AD-A155 804 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS ATHOL MANUFACTURING D.. (U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV MAR 79 1/1

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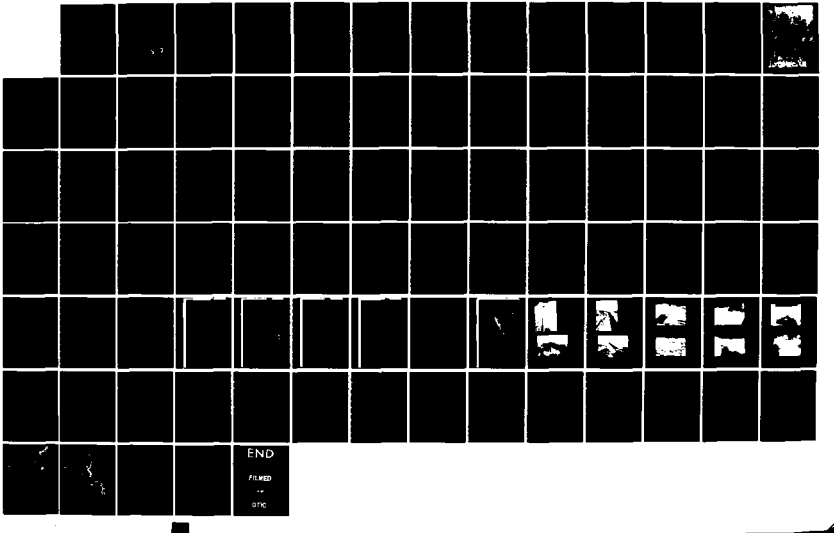

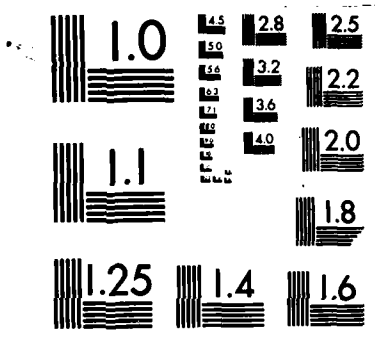

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CONNECTICUT RIVER BASIN

ATHOL MASSACHUSETTS

ATHOL MANUFACTURING DAM

MA 00932

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

MARCH 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: MA 00932	2. GOVT ACCESSION NO. AD-A155 804 / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)*: Athol Manufacturing Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS	5. TYPE OF REPORT & PERIOD COVERED: INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254	12. REPORT DATE: March 1979 13. NUMBER OF PAGES: 60
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)*: UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

DAMS, INSPECTION, DAM SAFETY,

Connecticut River BAsin
Athol, Massachusetts
Millers River

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The dam is a concrete, stone masonry and earth embankment dam. It is 396± ft. long and the maximum height is 19± ft. The visual inspection indicated the dam and appurtenant structures to be in generally good condition. It is small in size with a hazard potential of high. It is felt that certain items need attention.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF
NEDED

MAY 2 1979

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

I am forwarding to you a copy of the Athol Manufacturing Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Union Butterfield Drill Corporation, Athol, Massachusetts 01331.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No: MA 00932

Name of Dam: Athol Manufacturing Dam

Town: Athol

County and State: Worcester County, Massachusetts

Stream: Millers River

Date of Inspection: November 14, 1978

This dam is a concrete, stone masonry and earth embankment dam. It is composed of three main sections. These are a primary spillway, a side channel overflow spillway and and embankment section. The primary spillway is 79 feet long while the overflow spillway is approximately 170 feet long. A sluiceway, which can be used in electric power generation, and wasteway is also incorporated within the limits of this dam. The overall length is 396± feet and the maximum height is 19± feet. There is no record as to when the dam was originally built. Construction modifications were made in 1923, 1936 and 1956. The dam is owned by the Union Butterfield Corporation of Athol, Massachusetts.

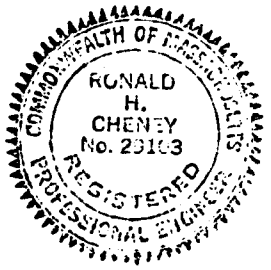
The visual inspection indicated the dam and appurtenant structures to be in generally good condition.

The dam is categorized as small in size and its hazard classification is high. According to the Corps guidelines for a Phase I investigation, the test flood is one half

Probable Maximum Flood. The inflow is 20,000 cfs, including an allowance for Birch Hill Dam base flow. The spillways for this dam are capable of passing this inflow without the dam overtopping. It is a run-of-the-river type project. Its storage capacity is very small, thus inflow and outflow are the same. Peak outflow from Birch Hill and peak inflow from the 25 s.m. drainage area are not assumed to coincide. Indepth engineering data was not available and therefore, the assessment of the dam is based primarily on the visual inspection, past performance history, and engineering judgement.

This dam is in generally good condition. It is felt, however, that certain items are in need of attention. These include the removal of small trees and mortaring of cobble joints at the overflow spillway downstream floor; removal of brush and trees at the upstream face of the dam; and removal of overhanging trees and repairing of spalling at the powerhouse canal training walls. The owner should also develop a formal system for warning immediate downstream areas in case of emergency.

After receipt of this Phase I Inspection Report, the above maintenance considerations should be implemented by the owner within 2 years and the warning system should be implemented within 1 year.



Ronald H. Cheney

Ronald H. Cheney, P.E.
Associate

Hayden, Harding & Buchanan, Inc.
Boston, Massachusetts

This Phase I Inspection Report on Athol Manufacturing Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph W. Finegan, Jr.

JOSEPH W. FINEGAN, JR., CHAIRMAN
Chief, Reservoir Control Center
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Inspections. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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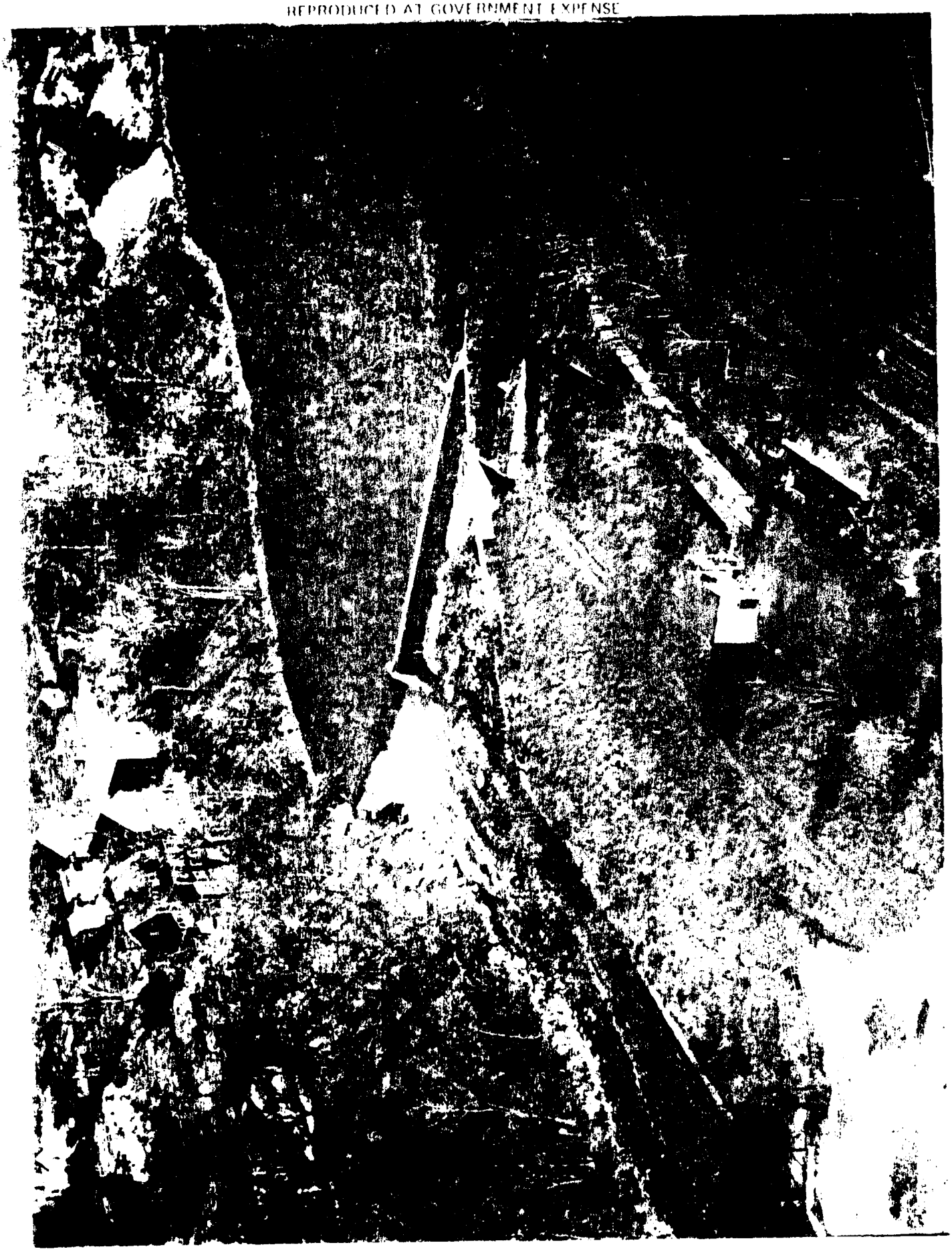


grass and small bushes, photo (2). As a result of the flat topography, the downstream toe was poorly defined. Seeps were not observed on the downstream slope of the dam.

The right abutment of the dam is the junction of the dam and overflow spillway. The junction appeared to be in good condition. The left abutment is a concrete retaining wall that serves as a training wall for the powerhouse canal gate structure.

c. Appurtenant Structures

Primary Spillway

The primary spillway abuts the right side of the river. The structure is bounded on the right by bedrock capped with a concrete block which serves as a training wall and on the left by a concrete training wall, photo(5). The upstream face, crest, downstream face, and apron of the spillway were under water and could not be observed. Flashboards were not present at the time of inspection.

Overflow Spillway

The overflow spillway is a masonry structure capped with concrete along the crest and upstream face, photo (4). This structure is bounded to the right by the primary spillway and to the left by the concrete earth-abutment dam. The water level was about 2 feet below the crest of the overflow spillway at the time of inspection. As a result, the upstream face of the spillway

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General

The Phase I field inspection of this dam was made on November 14, 1978. Water was overtopping the main spillway during inspection. The upstream face of the dam could only be inspected above this water surface.

b. Dam

Visual inspection of the dam indicated it is in good condition.

The upstream face of the dam is a reinforced concrete retaining wall, which is in good condition. Cracks that were observed on the face of the wall appeared limited to construction joint locations. The ground surface at the toe of the upstream face of the dam was densely covered with brush and small trees, photo (1). As a result, riprap on the ground surface was not observable.

The crest of the dam is the top of the concrete retaining wall and is about 24 inches wide. Minor cracks, at apparent construction joints, were observed along the crest. No evidence, however, of cracking or misalignment that could be attributed to wall movements was observed.

The downstream slope of the dam is an earth embankment that is relatively flat and covered with hay,

b. Adequacy

The lack of indepth engineering data does not allow for a definitive review. Therefore the adequacy of this dam, structurally and hydraulically, can not be assessed from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history, and sound engineering judgement.

c. Validity

The visual field inspection of this dam indicates the external features to agree with those shown on the 1936 and 1956 plans.

SECTION 2
ENGINEERING DATA

2.1 Design

Initial design data for construction of the original pre-1923 dam were not discovered. Subsequent dam modification plans were available for the years 1923, 1928, 1936 and 1956. These plans were found at the Worcester County Court House, Engineering Department.

2.2 Construction

No construction data regarding this dam was discovered.

2.3 Operation

The dam is operated by the Union Butterfield Drill Corporation of Athol, Massachusetts. No formal operation outline regarding this dam was available.

2.4 Evaluation

a. Availability

Dam modification plans, Inspection Reports prior to 1972, a County fact sheet and limited County correspondence were available at the Worcester County Court House, Engineering Department. A State Inspection Report from 1972 was available at the State Department of Environmental Quality Engineering Division of Waterways office at Boston, Massachusetts. A 1936 plan showing the then existing location plan and cross sections of the downstream retaining walls was made available by the owner.

j. Regulating Outlets

This dam has 3 regulating outlets. A 12' wide sluiceway channel located at the left end of the dam. Flow through this outlet is regulated by a manually operated 5' high, full width wooden sluice gate. The purpose of this sluiceway is to supply water for electric power generation during periods of high flow. A 6' wide by full height waste gate is located between the primary spillway and overflow side channel spillway. The waste gate is closed to top of overflow spillway by stop logs which can be removed manually. A 6' wide by 4' high trash gate is located near the southern end of the overflow spillway. Stop logs which could be removed manually, are in place for 1/2 the height of gate. In addition, the spillway has provisions for up to 2' of flashboards.

The discharge capacity over the spillways at the top of dam elevation of 578± is approximately 20,000 cfs. For the test flood of 20,000 cfs (½PMF), the stage elevation at the dam is 578±. (See Section 5.1.e)

c. Elevation (ft. aove MSL)

(1) Streambed at centerline of dam ---------- 559±

(2) Maximum tailwater---------- 586±

(3) Upstream portal invert diversion tunnel------ none

(4) Normal pool----------570±

(5) Full flood control pool----------N/A

(6) Spillway crest (ungated)----------569±

(7) Design surcharge (Original Design)------- unknown

(8) Top Dam ---------- 578±

(9) Test flood design surcharge----------578±

d. Reservoir

(1) Length of maximum pool--------(½ PMF pool) 2700'

(2) Length of normal pool----------400'

(3) Length of flood control pool---------- N/A

e. Storage (acre-feet)

(1) Normal pool----------290

(2) Spillway crest pool----------290

(3) Flood control pool----------N/A

(4) Top of dam----------360±

(5) Test flood pool----------360±

Directly below the dam is the City of Athol. There are a number of buildings and homes adjacent to the Millers River as it flows through this city. Downstream of Athol, there is little development adjacent to the river until it nears the City of Orange, about 3.5 miles downstream.

b. Discharge at Dam Site

The outlet works for this dam consist of a 12 foot wide sluiceway channel regulated by a 5 foot high, wooden sluice gate (invert elevation 560), a 6 foot wide by 4 foot high (invert elevation 567) trash gate blocked by stop logs, and a 6 foot wide waste gate (invert elevation 558), also blocked by stop logs. All are operated manually. The primary spillway has provisions for up to 2 feet of flashboards.

The dam was reconstructed in 1936 after the original dam at this site was washed out during the 1936 flood. Modifications were made to the spillway face and flashboard facilities in 1956. Specific records of maximum impoundment and spillway discharge are unavailable. A U.S.G.S. gaging station, No. 1-1640 is located about 7 miles upstream of the dam at South Royalston. This gage, which has a drainage area of 187 square miles, has been in operation since 1939. The maximum discharge recorded at the gage was 4,400 cfs for a stage height of 8.4 feet on April 13, 1940. Floodmarks at the site indicate that the September 1938 flood had a stage height of 15.9 feet.

i. Normal Operational Procedure

There is no formal operational procedure for this dam. The height of the pond can be regulated at low flow periods by placement of flashboards and stop logs. However, the height of water is usually dependant upon outflow of upstream dams and power generation demand. Flashboards were last installed about two years ago, and power generation last occurred during the spring of 1978.

1.3 Pertinent Data

a. Drainage Area

The drainage area (128,000 acres - 200 s.m.) is generally comprised of wooded, rolling hills. The main streams contributing drainage to this area are the Millers River, Otter River and North Branch Millers River, along with a number of smaller streams. Flow on these streams is regulated by a number of lakes, ponds, small dams, and the U.S. Army Corps of Engineers Birch Hill Flood Control Dam on the Millers River at South Royalston which regulates runoff from a 175 s.m. area.

Development within the area is generally rural in nature. The cities of Winchendon, Gardner, and Athol, as well as a number of smaller towns, are located adjacent to the major streams. The area is serviced by rail and air facilities, in addition to a number of State highways and local roads.

g. Purpose of the Dam

The canal and sluiceway feed water to a electric generation station some 300 feet downstream. This station is put on line when sufficient flow is available. Power is used by the owner. The station was last on line in the spring of 1978.

h. Design and Construction History

There is no record as to when the original dam was constructed. Prior to 1923, the dam had a wooden spillway. The composition of the overflow spillway and embankment at that time is unknown. In 1923, a concrete spillway with wood cribbing outlet, at about the same spillway location, was constructed. In 1927, "cement" head gates were installed for the canal. Further modifications were proposed at that time and shown on plans found at the Worcester County Commissioner's office, however, it is questionable as to whether these improvements were ever instituted. In 1936, the dam was rebuilt resulting in the general overall configuration of the existing structure. The work done in 1936 was designed by C.M. Allen and constructed by M.M. Day in the summer of 1936. Further modifications were made on the spillway face and flashboard facilities in 1956. This work was designed by Howard M. Turner, Consulting Engineer-Boston, Massachusetts. (see Section 6.1b)

of the dam could receive 3 to 4 feet of floodwaters due to dam failure based on Corps guidelines. The stream stage would be about 8 feet. Since this water raise would be rapid and workmen in the lower elevations would have little or no warning the hazard is classified as high.

It must be noted however that the present condition of the river upstream of the dam is heavily silted. This was alluded to by Mr. J. Hayden of Union Butterfield Drill Corporation owners of the dam. Outflow due to dam failure under existing conditions could be considerably less.

e. Ownership

The dam is presently owned by the Union Butterfield Drill Corporation. The dam was originally built by the Athol Manufacturing Company and owned by them until 1962. In 1962 the dam was taken over by Union Twist Drill Company who have since changed their name to Union Butterfield Corporation.

f. Operator

The caretaker of the dam is Mr. James Hayden; superintendant of the Union Butterfield Drill Corporation, Athol, Massachusetts 01331. Telephone (617) 249-3221.

left side. The waste gateway is a 6 foot wide by 15 foot high full stop logged structure. Adjacent and to the left of this gateway is the side channel overflow spillway. This structure has a height of 12 to 15 feet, a plan width of about 20 feet and a length of about 170± feet. It is comprised of mortared stone masonry with a concrete cap. Contained within the overflow spillway, at the left end is a 6 foot long by 4 foot deep trash gate which contains slots for for stop logs. The dam embankment contains a 1 to 3 foot wide, 19± foot high, 120 foot long concrete wall. The downstream embankment in front of the wall contains rock and miscellaneous soil backfill and is presently highly vegetated. Located at the left end of the embankment is a 12 foot wide, 16± foot high canal sluiceway. The sluice gate controls water to a channelway which can be used in power generation. The gate structure has concrete wingwalls, a metal frame walkway and provisions for raising the gate.

c. Size Classification

The dam is categorized as small according to its storage capacity of 360 acre feet and its height of 19 feet.

d. Hazard Classification

This dam has a high hazard classification. Dam failure analysis shows that the mill buildings downstream

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location

Athol Manufacturing Dam is located in the Town of Athol in Worcester County, Massachusetts. The dam spans the Millers River east of the town center. It is shown on the U.S.G.S Athol, Massachusetts Quadrangle, with coordinates approximately at North 42° 35' 48", West 72° 13' 6".

b. Description of Dam and Appurtenances

The 396± foot dam consists of 3 main sections. These are the primary spillway, the overflow spillway, and the dam embankment. The primary spillway consists of a 79 foot long, 13 foot high stone core concrete capped spillway and a waste gateway. The spillway contains provisions for 2 feet of flashboards. It has a 15 foot concrete abutment founded on rock outcrop on the right side and a 2 foot wide concrete training wall adjacent to the waste gateway on the

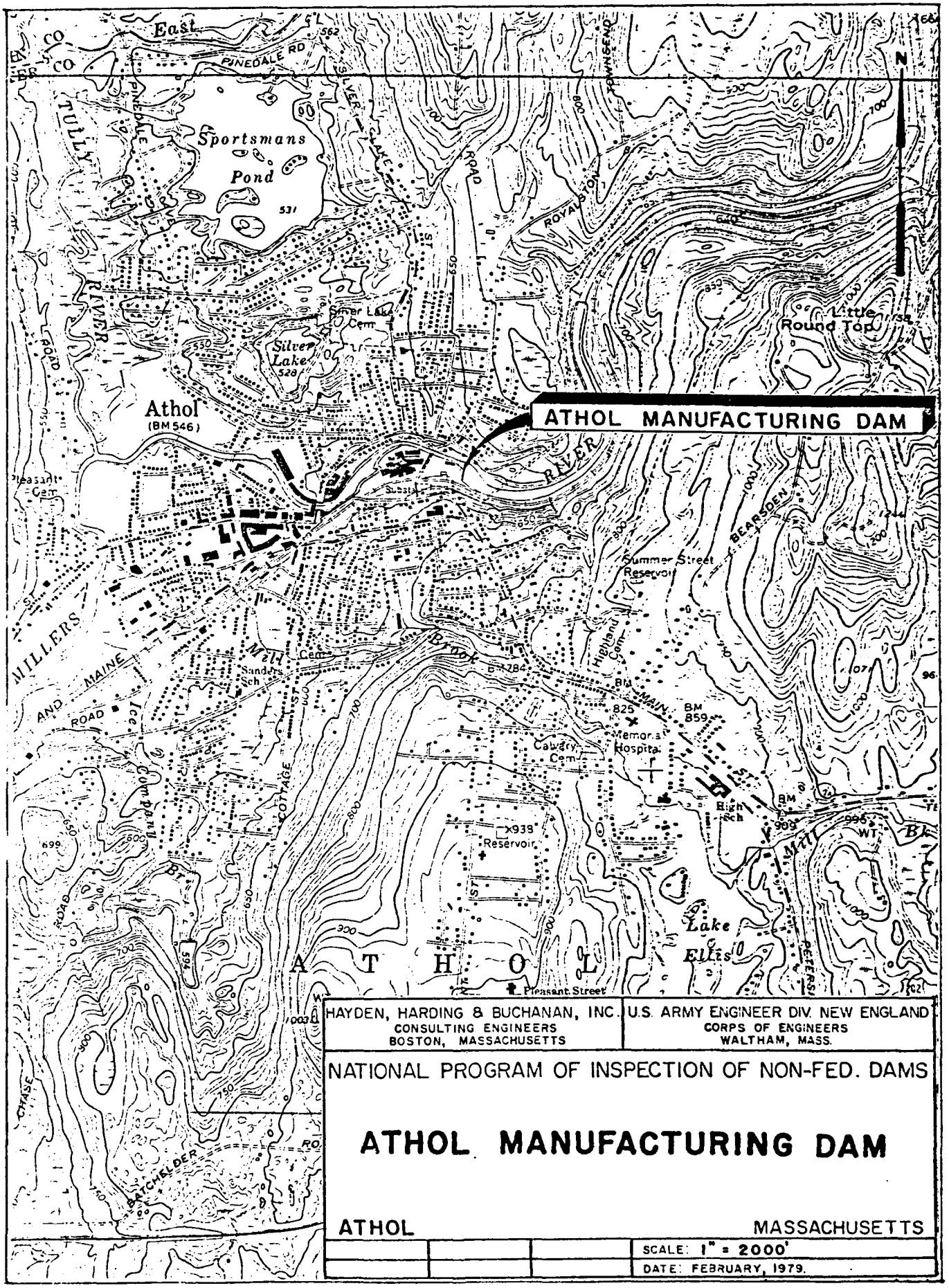
PHASE I
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: ATHOL MANUFACTURING DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Hayden, Harding & Buchanan, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued Hayden, Harding & Buchanan, Inc. under a letter of 28 November 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW 33-79-C-0012 has been assigned by the Corps of Engineers for this work.



HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

ATHOL MANUFACTURING DAM

ATHOL — MASSACHUSETTS

SCALE: 1" = 2000'

DATE: FEBRUARY, 1979.

could not be observed. The crest of the overflow spillway had cracks which appeared limited to construction joint locations. Cracks and misalignment of the crest are minor and not considered attributed to movements of the structure. The downstream face of the structure is mortared stone, photo (6). Weep holes present in the downstream face, and several feet below the upstream water surface, did not discharge any water. The downstream toe and channel of the overflow spillway consisted of cobbles grouted in place. The grouted cobble area is generally in good condition with some erosion, small trees and vegetation, photo(4). Seeps were not observed along the toe of the downstream face.

Outlet Trash Gate

A stop log structure exists at the junction of the overflow spillway and dam junction. This gate is approximately 6 feet wide by 4 feet high and consists of stop log grooves and stop logs. Stop logs were in place for about ½ height. Grooves are constructed of steel "H" sections, photo (7).

Outlet Waste Gate

This waste gate is a 6' wide by full height outlet consisting of an upstream concrete box inlet structure and downstream stop logs. It is shown to the right of the primary spillway in photo 5. The plans dated 1956 show major

repairs made to the stop log groove on the left side. Stop logs are normally kept in place for full height.

Outlet Sluice Gate (Powerhouse Canal)

This facility consists of concrete training walls, steel framed, hand operated wooden sluice gate and a service walkway. The training walls were in fair to poor condition with some spalling. The sluice gate and walkway appeared to be in good condition and were last used during the spring of 1978.

d. Reservoir Area

The visual inspection showed the area in the vicinity of the dam to be in general agreement with the U.S.G.S. map. Mr. Jim Hayden of Union Butterfield Corporation stated that the upstream river is full of silt and waste from upstream plants; and that water behind the dam is is not very deep. A description of the drainage area is given in Section 1.3 of this report.

e. Downstream Channel

The downstream channel is free and clear. The right side of the channel is stone lined with heavy vegetation. The left side is also stone lined and vegetated with a concrete retaining wall located parallel to the shoreline 10 to 15 feet inward. A steel framed truss roadway bridge is located approximately 500 feet downstream of the dam.

3.2 Evaluation

Visual inspection indicates the dam and appurtenant structures to be in good condition, except the training walls of the powerhouse canal, and the area downstream of the overflow spillway. Items observed that could affect the future stability of the dam are:

1. Roots from trees and bushes on the upstream face of the dam could gradually deteriorate the concrete retaining wall.
2. Spalling of powerhouse canal training walls could reduce stability of the walls. Failure of these walls could obstruct flow in the canal.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

There is no formal written operational procedure for Athol Manufacturing Dam. No flashboards have been used on the main spillway, or the overflow spillway in the past 2 years. Operation of the outlet sluice gate for power generation has not been attempted since the spring of 1978. The Union Butterfield Drill Corporation is responsible for the general maintenance and operation of the dam.

4.2 Maintenance of Dam

There is no formal written maintenance procedure for this dam. No known recent maintenance has been performed on the dam.

4.3 Maintenance of Operating Facilities

There is no formal written maintenance of the operating facilities for this dam. The power generation sluice gate was last operated during the spring of 1978. Operation of the waste gate and installation of flashing for the main spillway has not been attempted in over two years.

4.4 Description of any Warning System in Effect

There are no warning systems in effect at this facility.

4.5 Evaluation

The dam should be inspected every two years by qualified personnel who can identify conditions of concern which if left unchecked could jeopardize the safety of the dam.

SECTION 5
HYDRAULIC/ HYDROLOGIC

5.1 Evaluation of Features

a. General

This dam basically consists of concrete-stone masonry gravity structure with a 79' long primary spillway, a 6' wide waste gateway and a 170± overflow spillway. In addition, it has provisions for possible electric power generation, trash removal, and release of the upstream pond. The sluiceway for power generation is separated from the primary and overflow spillways by an earth embankment.

The initial inventory sheet classifies this dam as a flood control structure, but there is little additional storage available other than from the flood surcharge behind the dam. The backwater from a roadway bridge several hundred feet downstream of the dam tends to reduce the head differential above and below the dam.

b. Design Data

Hydraulic/Hydrologic data, criteria, and calculations used in the design and subsequent modifications of this dam are not available. Plans showing the proposed and actual modifications of 1927, 1936 and 1956 are available.

c. Experience Data

Information obtained from State and County Inspection Reports indicate that the original dam at this site was washed out during the 1936 flood. Additional data on maximum impound-

ments and discharge rates at this dam are unknown. A U.S.G.S. gage, No. 1-1640 located on the Millers River about 7 miles above the dam at South Royalston, has been in operation since 1939. The record flood for this gage, which has a drainage area of 187 square miles, was 4,400 cfs on April 13, 1940. The gage height was 8.4'. Highwater marks from the 1938 flood indicated a stage height of 15.9' at this site. Since 1942, flow on the river at and below this gage has been regulated by the Birch Hill Flood Control Dam located several miles upstream. Birch Hill regulates flow from a 175 s.m. area.

d. Visual Observations

Visual observations of the drainage area and general vicinity of the dam show them to be in general agreement with U.S.G.S. maps of the area. A description of the drainage area is given in Section 1.3 of this report.

e. Overtopping Potential

The dam carries a small classification for size with a high hazard potential, and as such, should be capable of passing a ½ PMF. This test flood was computed by obtaining the watershed drainage area from State Inspection Reports and using Corps discharge guide curves. A ½ PMF inflow of 17,500 cfs from an uncontrolled drainage area of 25 s.m. was developed. Birch Hill's base outflow is assumed to contribute 2,500 cfs , yielding a test flood of 20,000 cfs at elevation 578, approximate top of dam. Birch Hill controls runoff from a 175 s.m. area. Its large storage capacity ,

174,000. a-f, would have a significant affect on controlling runoff. Accordingly, peak flows at Athol are not assumed to coincide. Only a 2,500 cfs base flow is applied to the peak discharge from the lower 25 s.m. drainage area. Due to the low storage capacity, inflow equals outflow for this dam. This dam will not overtop under the test flood.

f. Failure Analysis

If the dam should fail with water at elevation 578.1, top of south abutment, 1412 cfs of water would be released from storage. The base flow would be 20,000 cfs. The failure flow then becomes 21,412 cfs. Damage in this case has already occurred, due to the existing high base flow. Failure flow is not significant.

With water at elevation 571, top of side channel overflow spillway, 7340 cfs of water is released from storage. The base flow is 700 cfs over the primary spillway, elevation 569. The failure flow is 8040 cfs. Damage appears to be limited to mill buildings about 1500 to 3000 feet downstream. Between 3 and 4 feet of inundation could occur. The stream stage would be about 8 feet. The dam, 300 feet downstream, could cause a backwater condition and deepen floodwaters. Beyond 3000 feet downstream, no damage appears to occur. The failure flow is dissipated within the river channel. However, buildings in this area are located along the stream channel, close to the level of flooding.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The visual observations did not disclose any immediate geotechnical or structural stability problems.

b. Design and Construction Data

Available records indicate the Athol Manufacturing Dam was constructed prior to 1923 and underwent extensive rehabilitation in 1923, 1936, and 1956. The reinforced concrete retaining wall serving as the upstream face of the dam was constructed in 1936. A drawing dated May, 1936 and traced in 1960, shows that a "sand fill" was placed to form an earth embankment on the downstream face of the wall. In addition to the retaining wall, a 12 inch thick concrete slab was constructed in front of the powerhouse canal gate structure and an existing stone retaining wall at the left abutment was faced with concrete.

The records indicate the concrete cap on the crest and downstream slope of the overflow spillway existed or was constructed in 1936.

Drawings dated June 20, 1956, show renovation details of the primary spillway. A new reinforced apron was constructed at the downstream toe of the primary spillway. The vertical face of the spillway is a

concrete retaining wall for about 64 feet and granite block wall for 15 feet. In 1956, the renovations included underpinning of the concrete wall footing and placement of 3 inch diameter steel pipes under the footing to relieve water pressures. Available drawings indicate the primary spillway is founded on bedrock.

c. Operating Records

Available records indicate a log apron at the downtream toe of the spillway was washed out in 1955.

A representative of the Athol Manufacturing Company indicated that one time, the dam was overtopped by several feet of water with only surficial damage to the dam.

d. Post Construction Changes

Post construction changes entailed renovations of the dam and appurtenant structures as presented in Section 6.1 b.

e. Seismic Stability

The dam is located in Seismic Zone 2, and according to USCE guidelines, it is assumed that there is no hazard from earthquake loading.

SECTION 7
ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

The visual inspection indicates the dam and appurtenant structures to be in generally good condition.

b. Adequacy of Information

The information made available along with the visual inspection, are adequate for a Phase I level of investigation.

c. Urgency

After receipt of this Phase I Inspection Report remedial measures presented in Section 7.3 should be implemented by the owner within 2 years. The exception is the remedial measure 7.3.a (4) which should be implemented within 1 year.

d. Necessity of Additional Investigations

No additional investigations is needed to complete this Phase I inspection.

7.2 Recommendations

There is no need for further engineering studies.

7.3 Remedial Measures

a. Operation and Maintenance Procedures

1. The small trees growing from between the mortared cobble joints at the overflow spillway downstream floor should be removed. All joints should be mortared as required.

2. The brush and trees located at the upstream face of the dam should be removed and the resulting excavations backfilled.

3. Spalling of the powerhouse canal training walls should be corrected and overhanging trees should be removed.

4. The owner should develop a formal system for warning immediate downstream areas in case of emergency.

5. The dam should be inspected every two years by qualified personnel who can identify areas of concern which left unchecked could jeopardize the safety of the dam.

7.4 Alternatives

Not applicable to this dam.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST

PARTY ORGANIZATION

PROJECT Athol Manufacturing Dam DATE November 14, 1978

TIME 1:00 PM

WEATHER cloudy

W.S. ELEV. 569.2 U.S. ____ DN.S.

PARTY:

1. R. Cheney	H H & B	6.	
2. D. Vine	H H & B	7.	
3. D. Lagatta	GEI	8.	
4. W. Fisher	GEI	9.	
5. J. Hayden	Union Butterfield	10.	

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam embankment	Daniel P. LaGatta	
2.	Control Spillway	Ron H. Cheney	
3.	High Water Spillway	Ron H. Cheney	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PROJECT Athol Manufacturing Dam DATE November 14, 1978

PROJECT FEATURE Concrete Earth Embankment Dam NAME Ron. H. Cheney

DISCIPLINE Structural Engineer / Geotechnical Engineer NAME Daniel P. LaGatta

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	578.06
Current Pool Elevation	2"± over top of primary spillway
Maximum Impoundment to Date	unknown
Surface Cracks	appear limited to construction jo...
Pavement Condition	Not applicable
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	None observed
Horizontal Alignment	None observed
Condition at Abutment and at Concrete Structures	Generally good-some cracking and spalling of concrete
Indications of Movement of Structural Items on Slopes	Not applicable
Trespassing on Slopes	None observed
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or near Toes	Unable to inspect toe of dam due to overflowing
Unusual Embankment or Downstream Seepage	None observed
Piping or Boils	None observed
Foundation Drainage Features	Weep holes in overflow spillway not discharging water
Toe Drains	Not known to exist
Instrumentation System	None
Vegetation	Considerable brush and trees on small embankment in front of concrete wall. Trunk diameters 6-in

TOWN Athol DAM NO. 02-04

LOCATION Millers River STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Athol Mfg Co. Place Athol Use

Inspected by L.O.M. - E.J. Teir Supt. Ed. Clair. Date June 13, 1960

Type of Dam Earth - Stone & Concrete spillway Condition Good
Stone & Concrete in Canal to Turbine

SPILLWAY

Flashboards in Place Carrying even with top of Embankment Recent Repairs None

Condition Remove 24" of Flashboards

Repairs Needed Appears O.K. except too many boards

[illegible]

Recent Repairs None

Condition Appears OK

Repairs Needed None

GATES

Recent Repairs None - appear ok

Condition carrying water too high against embankment & care!

Repairs Needed

Remarks Were visible

June 13, 1960 E. J. Marble County Engineer
E. J. Teir, Con. Asst. Dept. Public Works

TOWN Athol DAM NO. 02-04

LOCATION Athol Mfg Co Dam STREAM Millers R.

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Athol Mfg Co Place Athol Use _____

Inspected by LOM Date Feb. 2, 1959

Type of Dam _____ Condition _____

SPILLWAY - Full of ice - No evidence of flood damage

Flashboards in Place None Recent Repairs 3-4 yrs ago

Condition Replanked down stream face and southerly end

Repairs Needed None

_____

GATES

Recent Repairs 3-4 yrs ago

Condition Appears OK

Repairs Needed _____

_____

GATES

Recent Repairs _____

Condition _____

Repairs Needed _____

_____

Previous _____

_____ County Engineer

OWN Athol DAM NO. 82-062

OCATION Southeasterly of Chestnut Hill Rd STREAM Millers River

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

(Early) Athol Mfg Co. old Mill Pd and

wned by Union Twist Drill Co. Place Athol Use Storage Pond.

nspected by W.O.L. Date Nov. 24 1964

ype of Dam Earth stone and concrete Condition Good

PILLWAY

ashboards in Place 36" of pin boards in the eastern section Recent Repairs

ondition The remainder boards (44") near the western end of the spillway at

epairs Needed a 5'x5' opening. The splash stones below the spillway

[illegible] be [illegible] with concrete.

TE

epairs [illegible]

[illegible] that the mill buildings have been removed from

pairs Needed the old mill site.

ES

ent Repairs The canal gates are in good condition. The 20

dition 6'x6' wood gates to the power house with wood stems

airs Needed and rabbet type lifting apparatus, are pretty worn.

[illegible]

County Engineer

02-0

r 27, 1969 P.P.P. - Millers River

Union Twist Drill Co.

Flood Patrol - Good condition

No flash boards in place.

150' Concrete spillway and concrete wall.

TCNN Athol DAM NO. 02-04

LOCATION 600's Easterly of Chestnut Hill Rd. STREAM Millers River

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Union Twist Drill Co. Place Athol Use Stor.

Inspected by P.P- P.P.- EM Date 3-19-68

Type of Dam Stone-earth-concrete Condition Good

SPILLWAY

Flashboards in Place _____ Recent Repairs _____

Condition _____

Repairs Needed Flood Patrol

ABUTMENT

Recent Repairs _____

Condition _____

Repairs Needed _____

GATES

Recent Repairs _____

Condition _____

Repairs Needed _____

LEAKS

How Serious _____

Where _____

County Engineer

C. C. DOCKET NO.

LOCATION Millers River - just East of Chestnut Hill Ave. Above Starrett's.

DESCRIPTION OF DAM

Concrete & Crib - old spillway upstream Conc. Slab.
Earth - Downstream Masonry Wall - in River Bed

pe	
ngth	305.±
ght	11.5
ckness top	Old crest = 1'-6" - New Crest = 3.0
" bottom	
wnstream Slope	Old Crest = abt 1'6" - New Vertical Face
tream "	New slope = 3:1 - Old Slope = 3:1, Stone
gth of Spillway	258.17 - Depth - 7.0 - old crest - 79.0 = 2.5
of Gates	clean out 6.0 wide x 4.0 - El. at. & 83
ation of Gates	South Abt.
hboards used	None
lth Flashboards or Gates	
designed by	C.M. Allen - C.E. May 20. 1936.
constructed by	M.M. Day - Athol - Summer 1936.
constructed	New Work by Saunders Eng. Co. - 1923. - Nov.

GENERAL REMARKS

Plan approved by the Co. Com - 6-2-1936
Owned by the Athol Mfg Co.
Inspected: 8-8-1936 - L.O.M. G. Alling.
Patrol - 3-1-1939 - M.A. Casella.
" 3-16, " B.P. St. John.
Inspected: 4-13-1940 - L.O.M. Patrol.
" 2-19-1941 - " - V.J. Brown.
" 10-27-1942 - M.F. Hunt
" 5-20- " L.O.M.

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream	Millers River.
" " any other Streams	
Length of Watershed	
Width " "	
Is Watershed Cultivated	
Percent in Forests	
Steepness of Slope	
Kind of Soil	- Foundation - Hardpan - Boulders
No. of Acres in Watershed	201. Sq. miles = 128,640. Acres
" " " " Reservoir	checked = 199.2. Sq. miles
Length of Reservoir	
Width " "	
Max Flow Cu. Ft per Sec.	100. - 3.7 acres - Tot. 29,000. Ct
Head or Flashboards-Low Water	
" " -High "	

GENERAL REMARKS

Inspected: Oct. 25, 1943 - L.O.M.
" June 14, 1948 "
" Mar. 17. 1950 " 6-13-58 L.O.M. Telf
" Feb. 16, 1951 " 7-7-58 Supt. Clai
" 1962 - owned by Union Twis
Dec. 11 - L.O.M. - T.C. Drill Co. - T. Casella

2-Library Bureau 10-52260

LIST OF AVAILABLE ENGINEERING DATA

1. Construction Drawings dated 1923, 1928, 1936, and 1956.

   Location: Worcester County Court House
   Engineering Department
   Worcester, Massachusetts 01009

No design calculations were located.

APPENDIX B

ENGINEERING DATA

PROJECT Athol Manufacturing Dam DATE November 14, 1978

PROJECT FEATURE Service Bridge NAME Ron H. Cheney

DISCIPLINE Structural Engineer NAME Daniel P. LaGatta
Geotechnical Engineer

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	There is no service bridge.
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment and Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat and Backwall	

PERIODIC INSPECTION CHECK LIST

PROJECT Athol Manufacturing Dam DATE November 14, 1978

PROJECT FEATURE Spillway NAME Ron H. Cheney

DISCIPLINE Structural Engineer NAME Daniel P. LaGatta
Geotechnical Engineer

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	Approach channel is the Millers River itself which was free and open.
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Approach Channel	
b. Weir and Training Walls	Water was flowing over the main spillway and therefore the spillway could not be closely inspected. The high water side overflow spillway is of stone masonry with upstream concrete cap. Downstream face and top surface were in good condition. No water discharge from weep holes. Some small trees and erosion at downstream cobble floor. Discharge channel is the Millers River which was free and open. River bottom- is exposed bedrock and gravel. Immediately downstream of overflow spillway, cobbles have been grouted into place.
General Condition of Concrete	
Rust or Staining	
Spalling	
Any Visible Reinforcing	
Any Seepage or Efflorescence	
Drain Holes	
c. Discharge Channel	
General Condition	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	None.
Floor of Channel	
Other Obstructions	

PERIODIC INSPECTION CHECK LIST

PROJECT Athol Manufacturing Dam — DATE November 14, 1978

PROJECT FEATURE Sluiceway Channel — NAME Ron H. Cheney

DISCIPLINE Structural Engineer / Geotechnical Engineer — NAME Daniel P. LaGatta

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	There is no outlet structure.
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain Holes	
Channel (Sluicegate to canal to power station)	Training walls severely spalled in local areas.
Loose Rock or Trees Overhanging Channel	None observed
Condition of Discharge Channel	Condition of Raceway channel is fair to poor. Some small trees on banks above sluiceway walls of no serious concern. Sluiceway channel is open and free.

PROJECT FEATURE Outlets NAME Ron H. Cheney

DISCIPLINE Structural Engineer NAME Daniel P. LaGatta
Geotechnical Engineer

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	There is no transition and conduit.
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

PERIODIC INSPECTION CHECK LIST

PROJECT Athol Manufacturing Dam DATE November 14, 1978

PROJECT FEATURE Sluiceway NAME Ron H. Cheney

DISCIPLINE Structural Engineer NAME Daniel P. LaGatta
Geotechnical Engineer

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	Control tower at sluice gates on sluiceway is steel framed-wood deck. This tower is in generally good condition.
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	System is manually operated. Last operated in Spring of 1978. System appears in generally good condition and operable. Purpose of system is to supply water for electric power generation during periods of high flow.
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System in Gate Chamber	

PERIODIC INSPECTION CHECK LIST

PROJECT Athol Manufacturing Dam DATE November 14, 1978

PROJECT FEATURE Outlets NAME Ron H. Cheney

DISCIPLINE Structural Engineer NAME Daniel P. LaGatta
Geotechnical Engineer

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	No Approach Channel
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	There is a 6' wide by full height stop log waste gate located between the control spillway and the high water side channel spillway. The upstream concrete intake structure was submerged and not inspected. Stop logs in place full height of dam. There is another waste gate 6' wide by 4' high at left end of high water side channel spillway. Stop logs were in place to ½ the height.
Condition of Concrete	
Stop Logs and Slots	

TOWN Athol DAM NO. 02-04

LOCATION Millers River STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Athol Mfg Co. Place Athol Use

Inspected by Long Date Oct 11, 1958

Type of Dam Condition Good

SPILLWAY

Flashboards in Place None Recent Repairs 2 yrs ago

Condition Looks good

Repairs Needed None

[illegible]

Repairs

Condition Good

Repairs Needed

GATES

Recent Repairs Rebuilt gate wing wall

Condition Good

Repairs Needed

[illegible]

Could not tell accr flow Hd

[illegible] 1958 C.O. Jones County Engineer

TOWN Athol DAM NO. 02-07

LOCATION _____ STREAM Millers River

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Athol Mfg Co. Place Athol Use Htr Sup, Pr

Inspected by L.O.M. Date July 2, 1958

Type of Dam Spillway - upstream concrete walls - Embankment Condition _____

SPILLWAY

Flashboards in Place Yes Recent Repairs Rebld gate structure

Condition Good

Repairs Needed None

Recent Repairs None

Condition Good

Repairs Needed None

GATES

Recent Repairs Rebuilt on Abt wall to Gate Structure

Condition Good

Repairs Needed None

Remarks Dam in use

Inspected _____ Approved _____ County Engineer

TOWN Athol DAM NO. 02-04

LOCATION Millers River STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS
DAM INSPECTION REPORT

OWNED BY Athol Mfg Co. PLACE Athol USE power etc

INSPECTED BY L.A.H. Julian White DATE May 24 1956

TYPE OF DAM CONDITION Section spillway
Conc log apron washed out is poor.

SPILLWAY

FLASHBOARDS IN PLACE None RECENT REPAIRS None

CONDITION log apron washed

REPAIRS NEEDED 4' to be rebuilt

EMBANKMENT

RECENT REPAIRS None

CONDITION Good

REPAIRS NEEDED None

GATES

RECENT REPAIRS None

CONDITION good, except at section near log apron

REPAIRS NEEDED Rebuild concrete wall

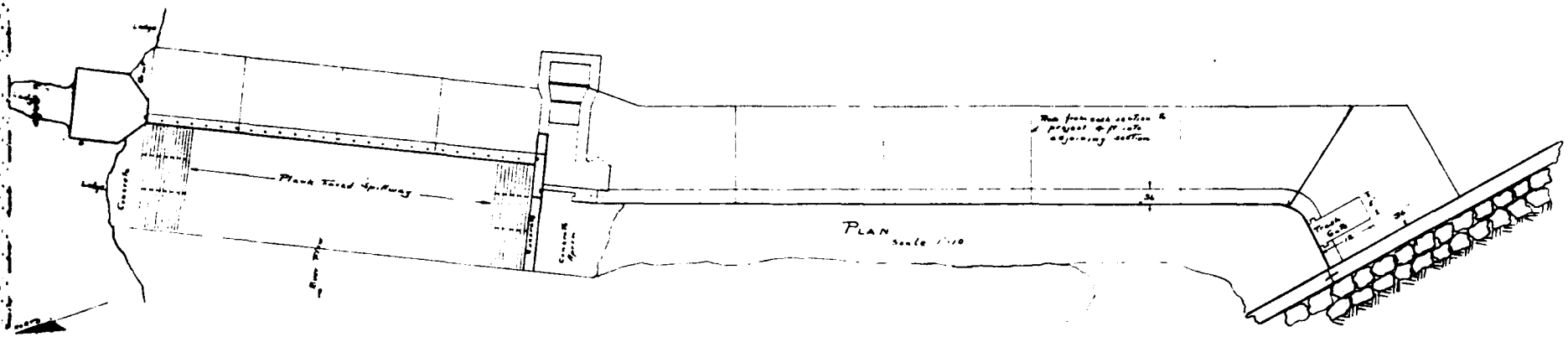
LEAKS

HOW SERIOUS None visible

DATE

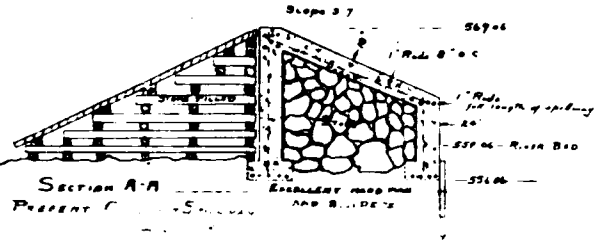
COUNTY ENGINEER

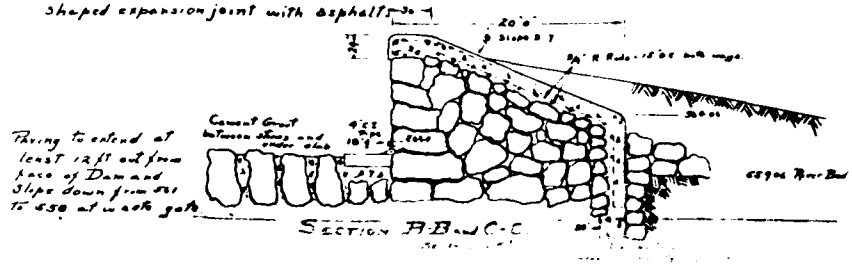
9



Area of Pond 8.5 Acres
Area of Watershed 201 Sq Miles
Elevations shown above sea level.
G E. Alling

Concrete Top Slab and Toe Wall
to be poured continuously in about
30 ft horizontal sections with wedge
shaped expansion joint with asphalt





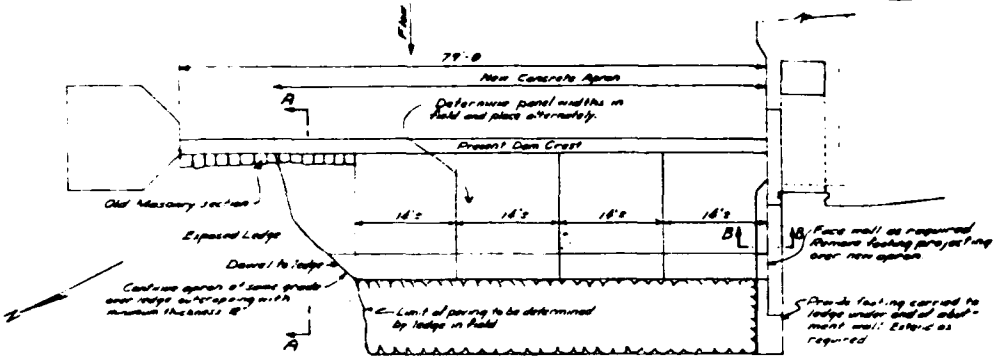
Engineered and Approved by _____

REDUCED

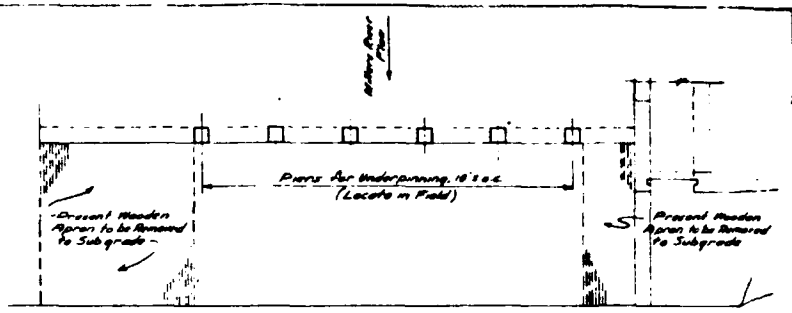
WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING DEPARTMENT
PLAN OF
RECONSTRUCTION OF DAM
AT MILLERS RIVER
ATHOL, MASS.
FOR ATHOL MANUFACTURING COMPANY
AS FILED AND APPROVED BY THE
COUNTY COMMISSIONERS

SCALES AS NOTED

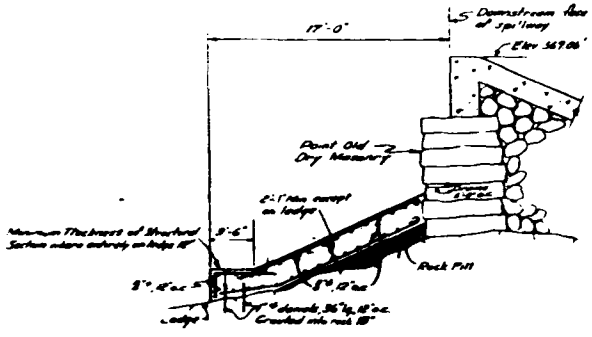
Approved: June 2, 1926 — Chairman and Clerk
Submitted for Approval: June 2, 1926 — County Engineer



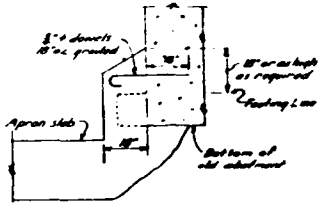
PLAN OF APRON
Scale 1"=8'



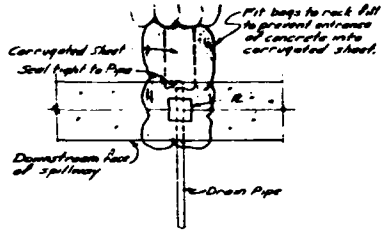
PLAN SHOWING LOCATION OF UNDERPINNING
1"=8'



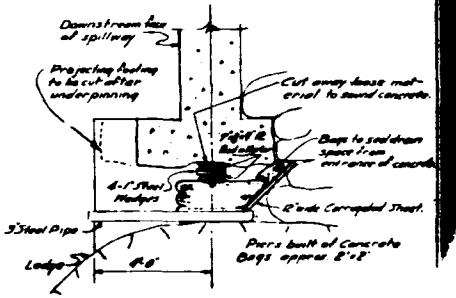
SECTION A-A
Apron detail of old masonry section of spillway



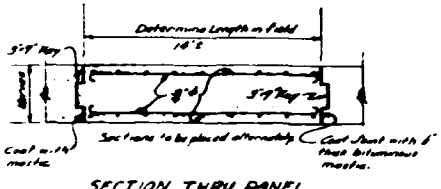
SECTION B-B
1"=8'



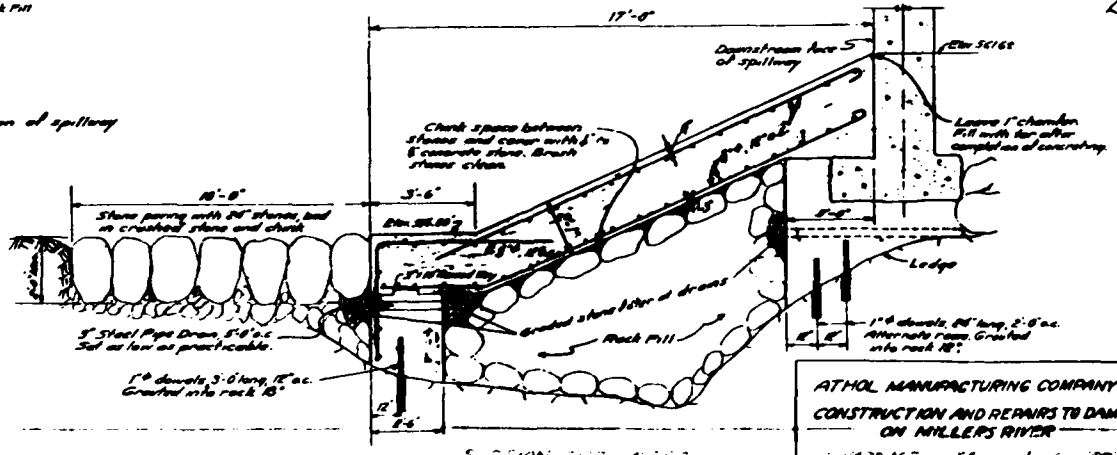
PLAN OF UNDERPINNING PIER
1"=8'



DETAIL OF UNDERPINNING
1"=8'

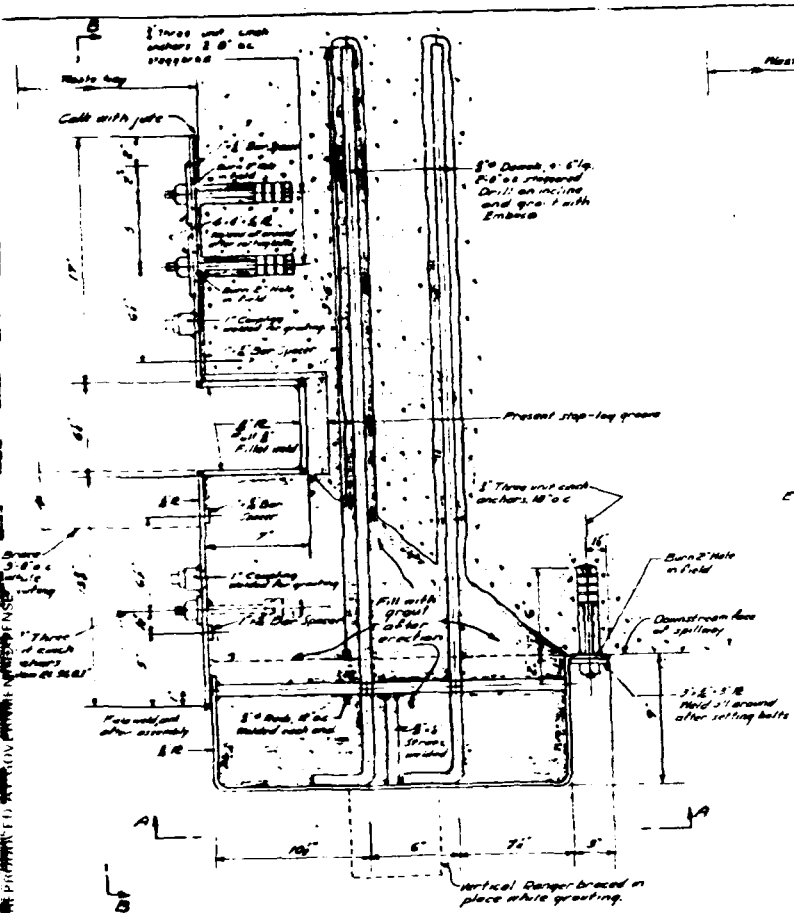


SECTION THRU PANEL
1"=8'



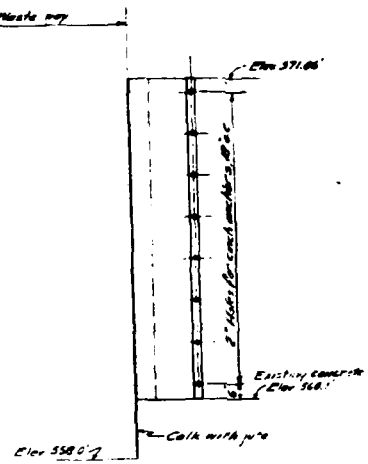
SECTION THRU APRON

ATHOL MANUFACTURING COMPANY
CONSTRUCTION AND REPAIRS TO DAM ON MILLERS RIVER

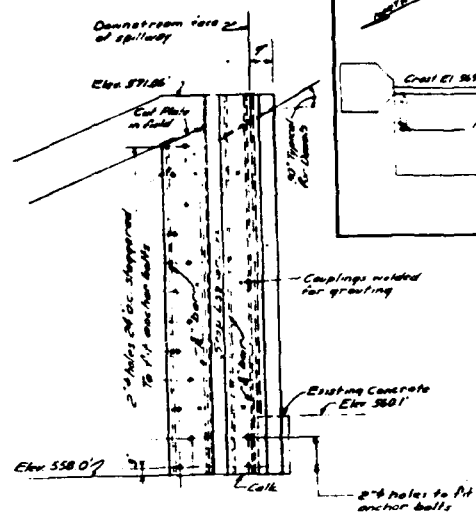


DETAIL "X"
1"=1'

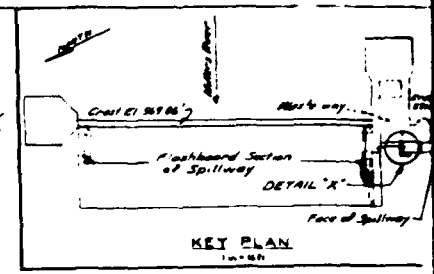
STOP-LOG GROOVE REPAIR



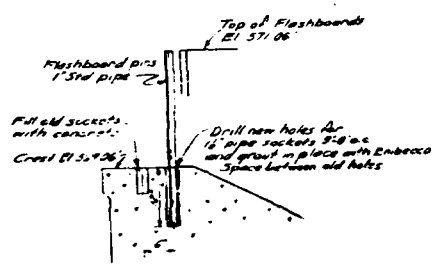
SECT A-A
1"=1'



SECT B-B
1"=1'



KEY PLAN



REPAIRS TO FLASHBOARD SOCKETS
No Scale

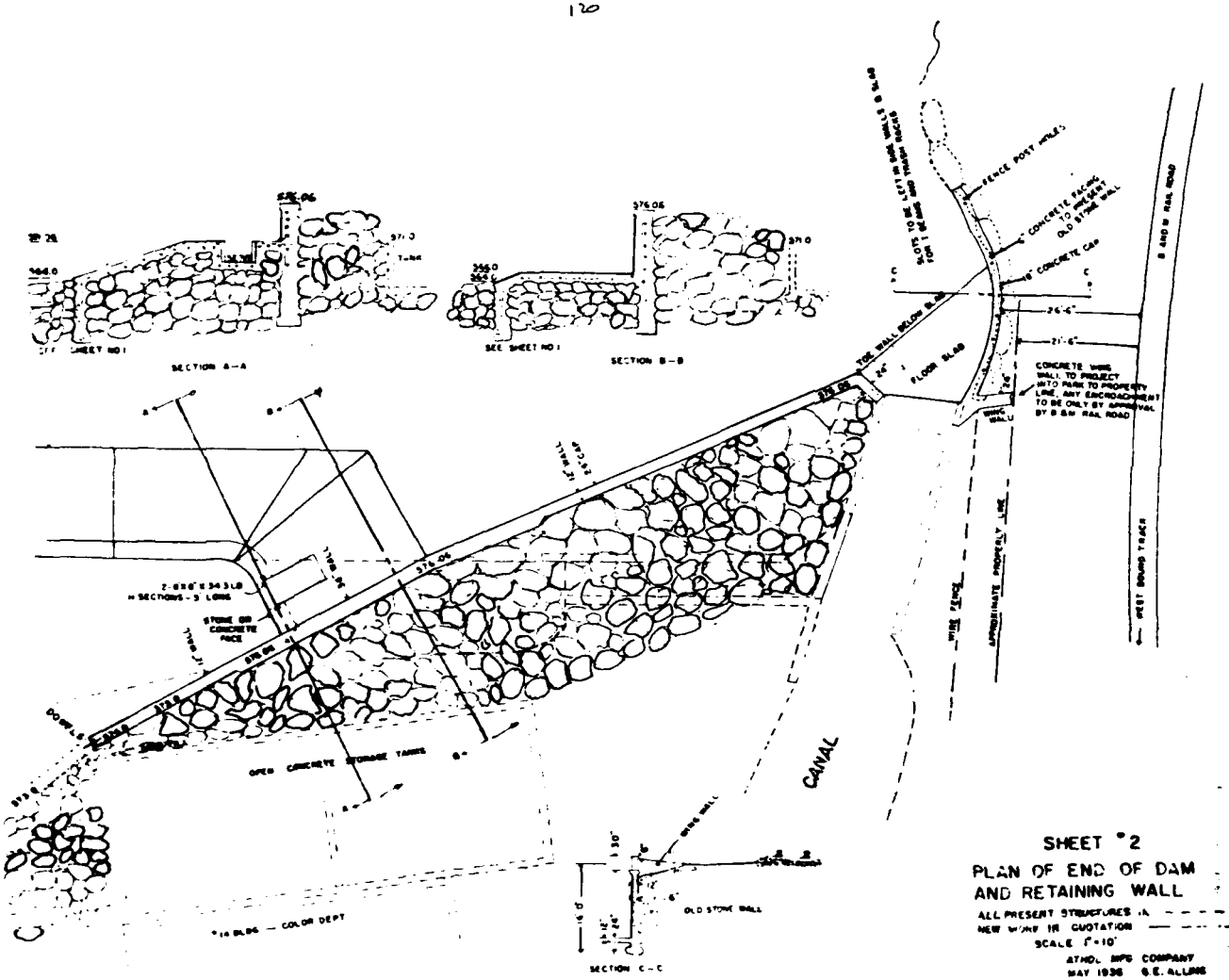
Note Exposed faces of steel to be given 2 Shop coats of red lead. Damaged areas to be touched up in field with red lead field coat of paint to be selected

REDUCED

ATHOL MANUFACTURING COMPANY
CONSTRUCTION AND REPAIRS TO DAM
ON MILLERS RIVER

ATHOL SHEET 2 OF 2 SHEETS

120



SHEET #2

PLAN OF END OF DAM AND RETAINING WALL

ALL PRESENT STRUCTURES IN _ _ _ _ _

NEW WORK IN OUTLINE ——— ———

SCALE 1"=10'

ATHOL MFG COMPANY

MAY 1936 G.E. ALLEN

REDUCED

WORCESTER COUNTY COMMISSIONERS

WORCESTER COUNTY ENGINEERING DEPARTMENT

PLAN OF

DAM

AND RETAINING WALL

ATHOL, MASS

FOR ATHOL MFG COMPANY

AS FILED AND APPROVED BY THE

COUNTY COMMISSIONERS

MEETING DOCKET

SCALES AS NOTED

TRACED BY P.P.P. 1968

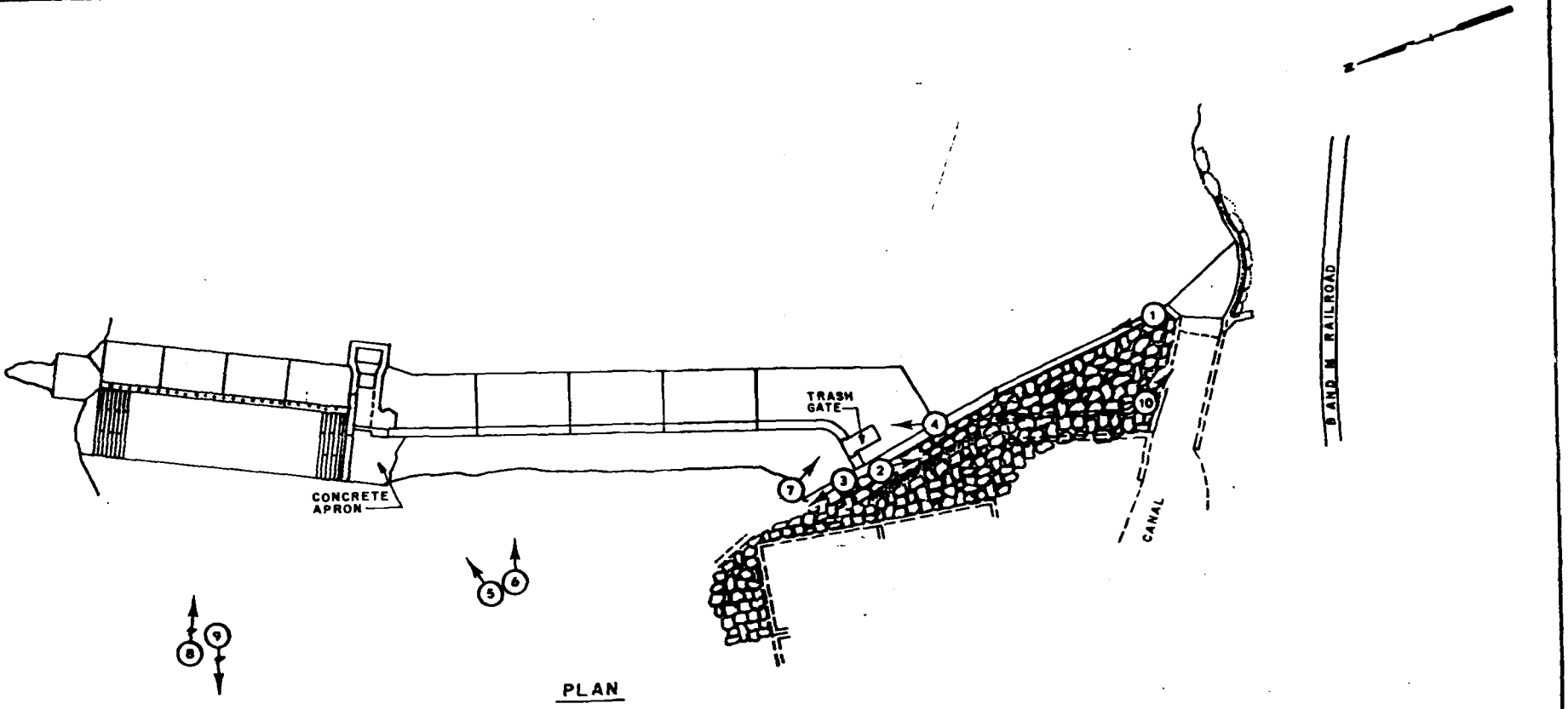
TRACING CHECKED BY W.D.L. 1968

DAM NO 02-04

COUNTY ENGINEER

APPENDIX C

PHOTOGRAPHS



PLAN

HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION OF PHOTOGRAPHS
ATHOL MANUFACTURING DAM

ATHOL MASSACHUSETTS

PHOTO NO. 1 - Crest of dam (top of concrete retaining wall) viewed from the left abutment. Note dense brush and tree growth on upstream side of the dam.

PHOTO NO. 2 - Slope of earth embankment downstream of concrete dam viewed from the right abutment.

PHOTO NO. 3 - View of concrete retaining wall extending downstream from the dam-overflow spillway junction.

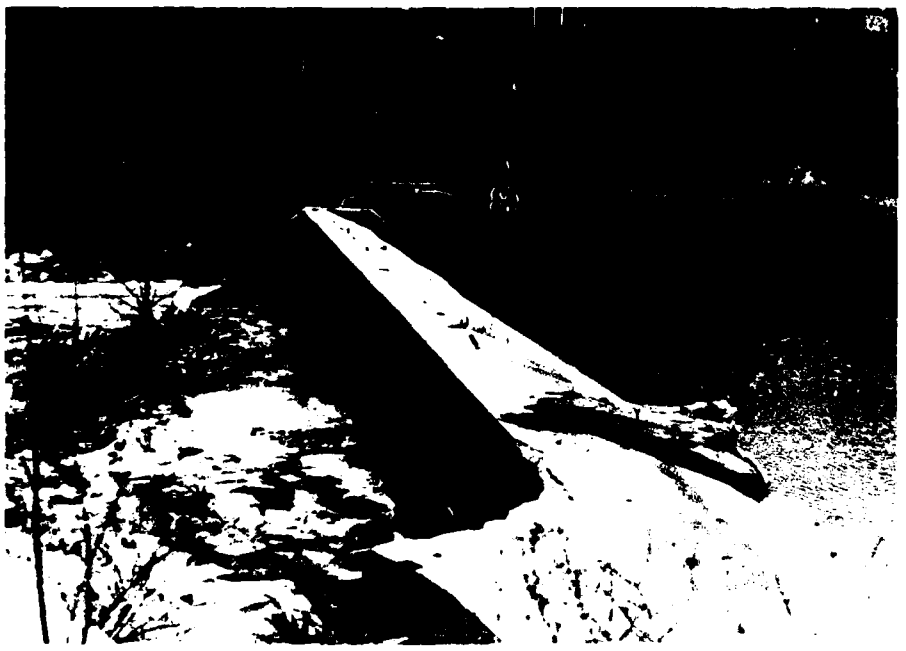


PHOTO NO. 4 - Overflow spillway viewed from junction with the dam. Note spalling of concrete at the bend in the structure and cobbles grouted in place along the toe.

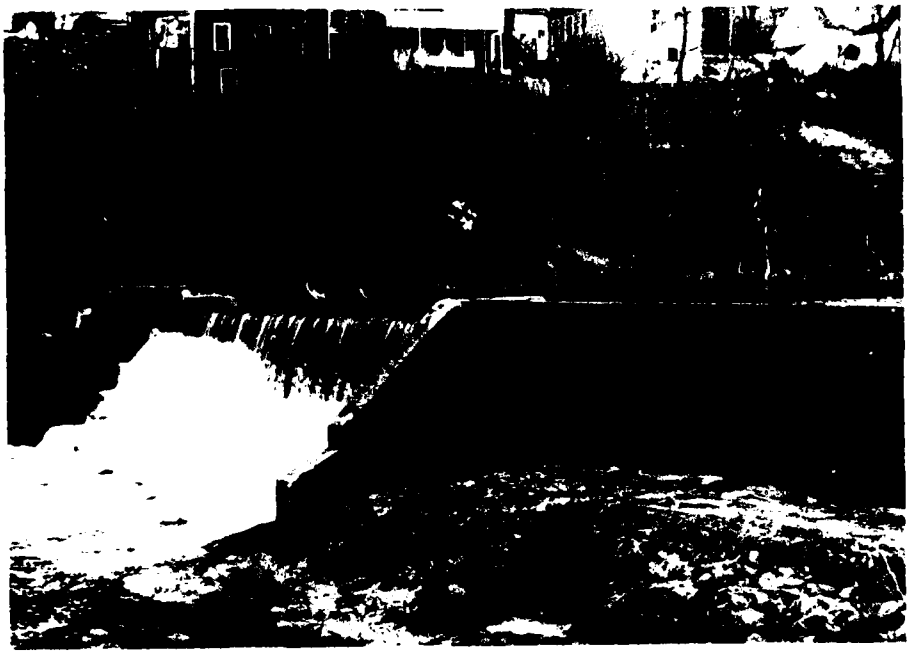


PHOTO NO. 5 - Primary spillway. Note right abutment on bedrock and position of flash board pins.

PHOTO NO. 6 - Downstream face of overflow spillway. Note water is not discharging from drain pipes.

PHOTO NO. 7 - Downstream face of outlet trash gate.

PHOTO NO. 8 - Downstream channel of main spillway viewed from downstream roadway bridge.

PHOTO NO. 9 - Millers River downstream of roadway bridge viewed from bridge.

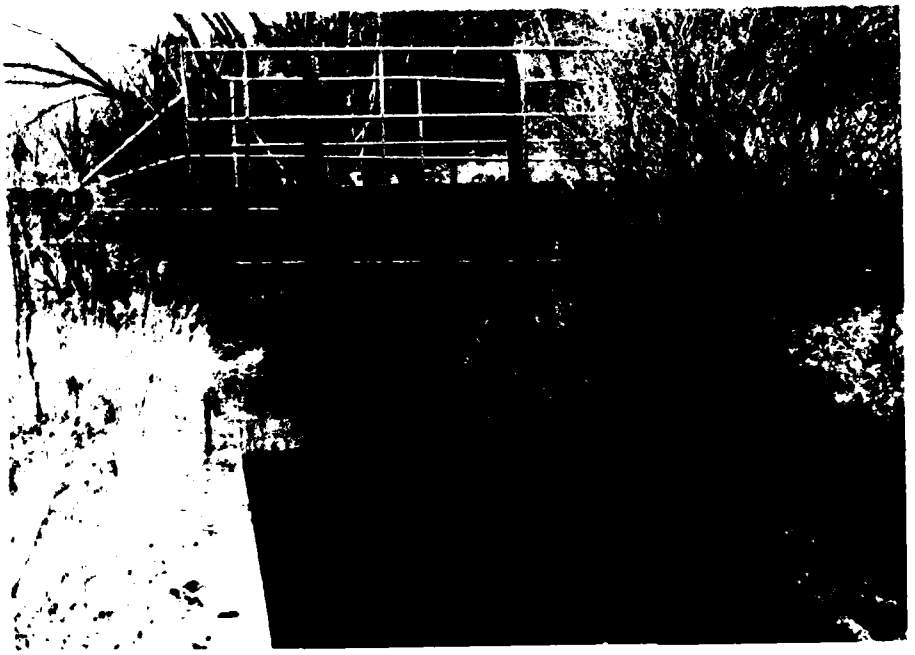
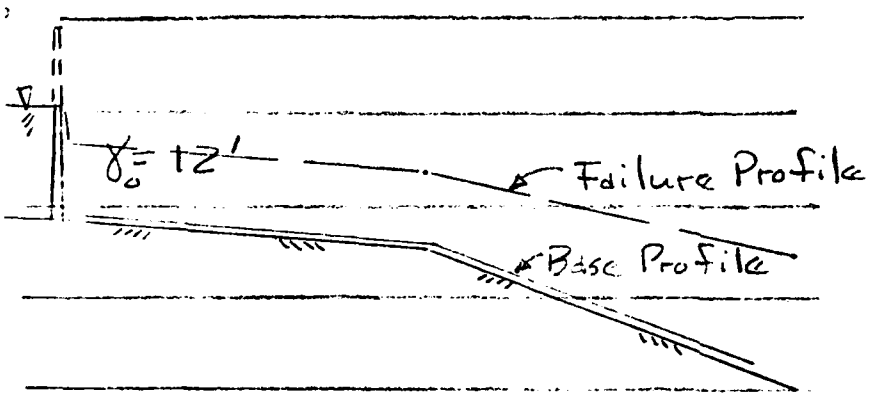


PHOTO NO. 10 - Downstream view of outlet sluice gate and service walkway. Facility is used in power generation.

Water @ 571 (TOP OF OVERFLOW SPILLWAY)

Q_{base} = 700 cfs depth in stream about 0.5 ft.

$Q_F = 8/27 \times 105 \times \sqrt{32.2} \times (12)^{1.5} = 7340$ cfs



Base Q	Fail Q	Base Elev	Fail Elev
700	8040	555.5	563.5
700	8040	540.5	555
525	6553	543.5	554
320	4000	517.5	522.5
185	2300	510.5	514.5

Damage due to dam failure:

Sect 1 nothing
Sect 2 mill bldgs @ el 552± WATER DEPTH 3'±
" 3 mill bldgs @ el 550 " " 4'±
" 4 nothing
" 5 nothing

dam @ Sect 3 could cause high backwater - more flooding, need bldg elevations!

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON MASSACHUSETTS

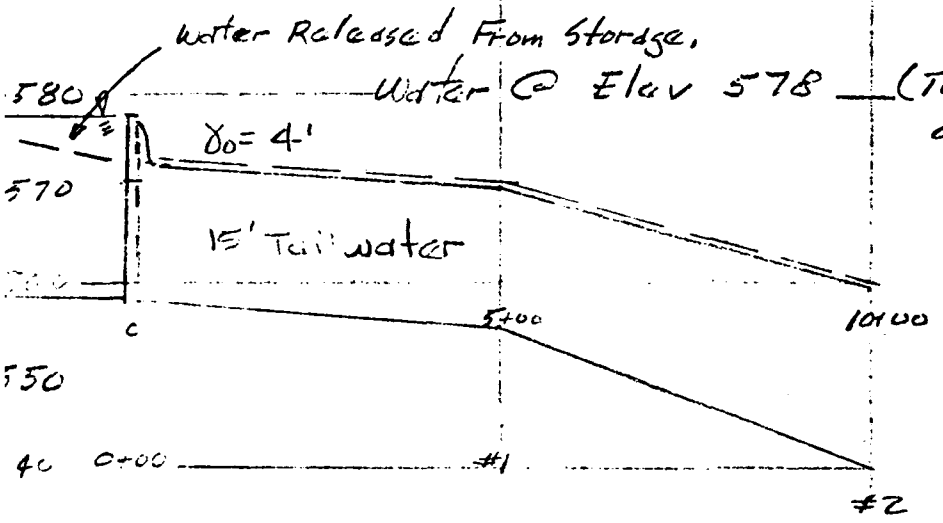
SHEET NO. 12
JOB Dams
SUBJECT Athol
CLIENT Corps

Failure Analysis

$$Q_F = \frac{8}{27}(.4 \times 26\tfrac{2}{3})\sqrt{32.2}\,(4)^{1.5} = 14.12 \text{ cfs}$$

Top Dam = 578.1
River Bed = 559.1

Flow = 20300 cfs just prior to failure



Section #	Base Q	Failure Q	Base Elev	Fail Elev
1	21260	21672	570.0	570.5
2	20210	21672	559.0	559.5
3	15200	16259	537.5	538
4	9200	9840	524.5	525
5	5300	5669	516.5	517

Q_{p_1} = 20,300. Storage = 360 ac-ft for 0.034"
Q_{p_2} = 22,227 Q_{avg} = 20260±

Damage Due to flooding prior to dam failure

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

SHEET NO. 11
JOB Dam Safety Inspect
SUBJECT Athol Mun Dam
CLIENT COE

MA

Past Flood and Other Hydrologic Data

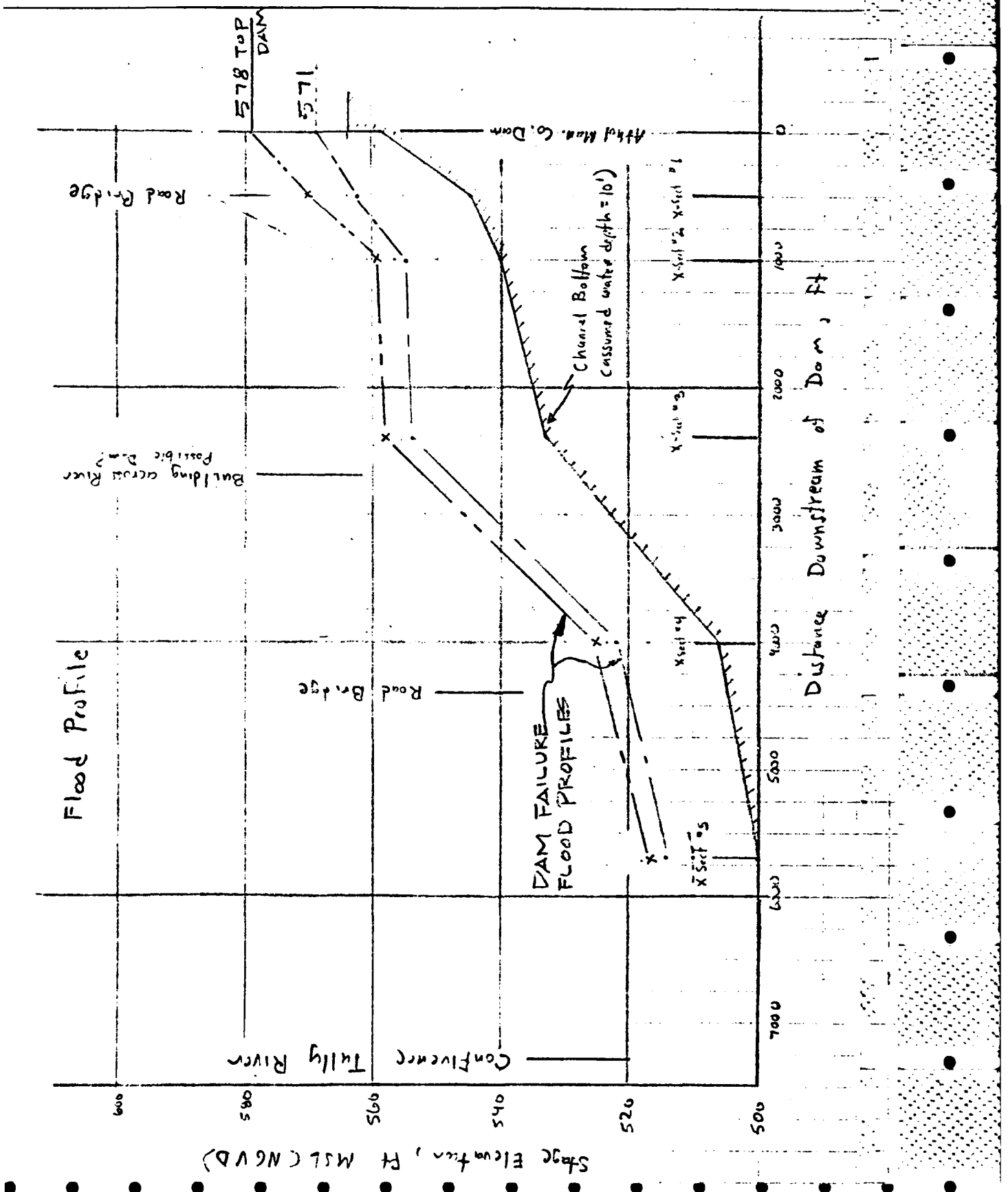
No.	Gage Location	D.A. sq. mi	Peak Flood Discharge	Date	Comments
0	Millers River near Winchendon, Mass.	83	8,500 cfs	9/22/38	'38 CSM = 102 cfs/sm
10	Millers River @ S. Royalston, Mass	187	4,400 cfs (Gage Ht = 8.8')	4/13/40	MAX. GAGE EL. RECORD = 15.9' 9/21 or 22/38; no discharge available
5	Millers River @ Farley, Mass	375	29,000 cfs	9/22/38	'38 CSM = 77 cfs/sm

Maximum Probable Flood Flows - NED Reservoirs nearby

Project	D.A. sq. mi	MPF cfs/sq. mi	Discharge cfs.
Tully	50	940	47,000
Birch Hill	175	505	89,500

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

SHEET NO. 10
JOB Dam Safety Inspec
SUBJECT Ashuelot Dam
CLIENT City

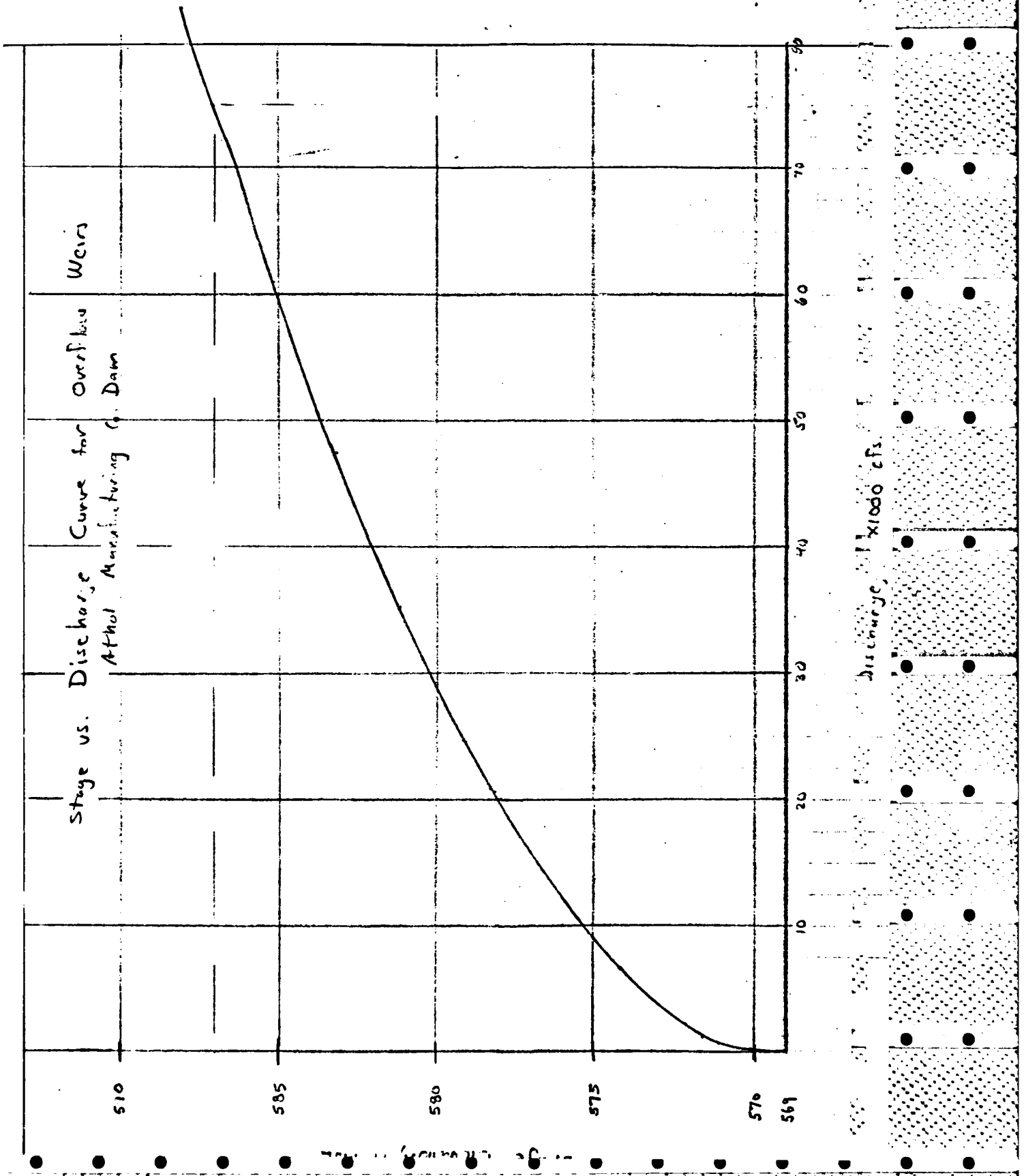


Approximately 1600' downstream of X-Section #5 the Tully River joins the Millers River. Flooding below this point would result from a combination of the flows from both streams. Flooding upstream could also be increased due to the potentially higher backwater at the confluence of these two rivers. The analyses required to determine the effect of the combined flood flows from Millers River and Tully River are beyond the scope of this study. Several homes and structures along North Orange Road and South Main St. in the vicinity of the confluence of these two rivers could suffer flood damage

73.244
12/26/78
FDD
MA

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

SHEET NO. 8
JOB Dam Safety Insp. [illegible]
SUBJECT Hydraul. Mod. Da
CLIENT COE



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class 2
FDS
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HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

SHEET NO. 7
JOB Dam Safety Inspec
SUBJECT Athol Mun. Dam
CLIENT COE

Water Elev.	H, ft	$H^{3/2}$	C	L ft	Q cfs.
585.1	16.0	64.0	3.32	91	19,340
	14.0	52.38	"	184	32,000
	13.5	49.60	"	15	2470
	7.0	18.52	"	117	7190
					61,000
586.1	17.0	70.09	3.32	91	21,180
	15.0	58.09	"	184	35,490
	14.5	55.21	"	15	2,750
	8.0	22.63	"	117	8,796
					68,210
587.0	17.9	75 73	3.32	91	22,880
	15.9	63.40	"	184	38,730
	15.4	60.43	"	15	3,010
	8.9	26.55	"	117	10,310
					74,930
589.0	18.9	82.17	3.32	91	24,820
	16.9	69.48	"	184	42,440
	16.4	66.41	"	15	3,310
	9.9	31 15	"	117	12,100
					82,670

NO. 76 244
12.12.78
FDD
BY MA

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

SHEET NO. 6
JOB Dam Safety Inspect.
SUBJECT Alt. 2 Flow Data
CLIENT COE

Water Elev.	H, ft	$H^{3/2}$	C	L, ft	Q, cfs
572.1	3.0	5.20	2.92	91	1380
	1.0	1.0	2.65	184	490
	0.5	0.35	2.63	15	10
					1880
574.1	5.0	11.18	3.32	91	3380
	3.0	5.20	2.92	184	2790
	2.5	3.95	2.81	15	170
					6340
578.1	9.0	27.0	3.32	91	8160
	7.0	18.52	3.32	184	11,310
	6.5	16.57	3.32	15	830
					20300
579.1	10.0	31.62	3.32	91	9550
	8.0	22.63	3.32	184	13820
	7.5	20.54	3.32	15	1020
	1.0	1.0	2.65	117	310
					24,700
581.1	12.0	41.57	3.32	91	12,560
	10.0	31.62	3.32	184	19,320
	9.5	29.28	3.32	15	1,460
	3.0	5.20	2.92	117	1780
					35,120
583.1	14.0	52.38	3.32	91	15,830
	12.0	41.57	3.32	184	25,390
	11.5	39.0	3.32	15	1940
	5.0	11.18	3.32	117	4340
					47,500

&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

JOB Dam Safety Inspect
SUBJECT Athol Mun. Dam
CLIENT COE

Determine Overflow Capacity of Dam

Have various length "weirs" at several heights and lengths

To simplify calcs, assume "split weirs" equivalent to weir equal to their combined length.

Also, to simplify determination of weir coefficients use coefficients for broad crested weir
C from Table 5-3 Kings "Handbook of Hydraulics")
Use max length weir = 407'

Use weir formula to determine discharge:

$Q = CLH^{3/2}$ with H varying, and C & L depending upon H

For conditions when have weirs of different heights determine Q for each elev. & use the sum to get total overflow discharge.

Water Elev.	H ft	$H^{3/2}$	C	L ft	Q cfs
569.1	0	0	—	—	0
570.1	1.0	1.0	2.65	91+[illegible]-91	240
571.1	2.0	2.83	2.72	91	700
571.6	2.5	3.95	2.81	91	1010
	0.5	0.35	2.63	184	170
					1180

DATE 11/6/79
BY FDD mA
CH'D BY

HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

JOB Dam Safety Inspect
SUBJECT Athol Mass
CLIENT COE

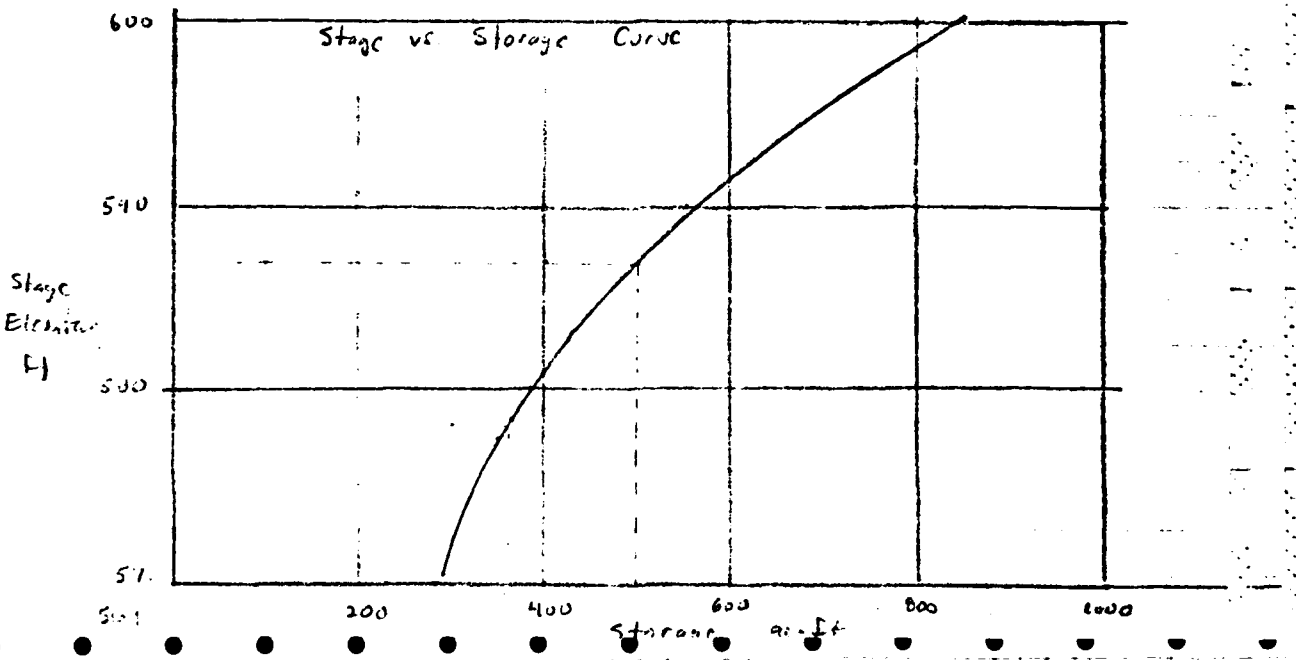
Determine Storage Capacity of Dam

Normal Pool Storage = 290 ac-ft @ Pool Elev = 570±

Planimeter area from USGS Quad Sheet (Athol Quad)

Elev.	R_1	R_2	R_3	R_{AVE}	Area s.m.	Area acres
570	.07	.05	.06	.06	.00558	5.5
580	.16	.13	.14	.15	.02145	13.7
590	.22	.22	—	.22	.03146	20.1
600	.44	.41	.42	.42	.06006	38.4

Storage Elev.	Area s.m.	Height ft	Incr Storage ac-ft	Cum Storage ac-ft
570	5.5	—	—	290
580	13.7	10	96	386
590	20.1	10	169	555
600	38.4	10	293	848



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12/12/72
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INA

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

SHEET NO. 3
JOB Dam Safety Inspect
SUBJECT Athol Main Dam
CLIENT COE

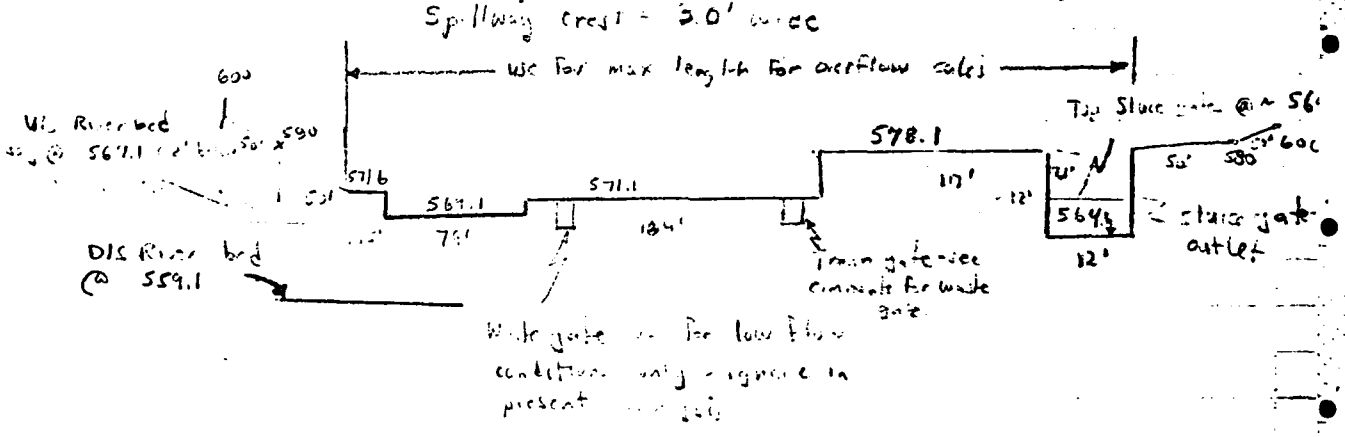
Test Flood

Birch Hill intercepts runoff from 175 s.m. area. Storage capacity 174,000 a-f. Will cause significant reduction of flow at Athol Mfg Dam. Peak discharge from Birch Hill and that of 25 sm. direct runoff area are not assumed to coincide. Time lag in reservoir & 4 to 5 hr river flow time are significant. Allow for Birch Hill discharge of 2500 cfs. ref. See Master Manual of Reservoir Regulation Appendix F, Dept of Army

1) Guide Curves (Mtn-Rolling)
for 275 sm & 1/2 PMF = 17,500 cfs
3) Allowance for Birch Hill
Flow as Base Flow = +2,500.
Test Flood = 20,000 cfs

Q_{p_1} = 20,000 El. = 578.0 Stor. = 350 a-f − 285 = 65 = .05"
storage Δ 0

$Q_{p_2} = Q_{p_1}$ = 20,000 cfs



Waste gate ... for low flow condition only - ignore in present ...

For worst condition assume all gate closed @ time of flood

Also neglect walkways, piers, & gate structure at sluice gate outlet

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

SIZE CLASSIFICATION

Height = 12 - Small
Max. Imp. Cap. = 345 a-ft - Small

∴ Use Small Size Classification

HAZARD POTENTIAL CLASSIFICATION

Developed area of Town of Athol located downstream on both sides of River. Potential for high property damage and possible loss of life exists, depending upon depth of flooding downstream.
For now use High Hazard Potential - may revise downward later on.

Test Flood

High Hazard, Small Size

Range : ½ PMF to PMF

USE ½ PMF

Total drainage area above dam 200± s.m.

JOB NO. 79 244
DATE 12-1-79
BY JD
CHKD BY MA 12/28

HH&B HAYDEN, HARDING & BUCHANAN, INC.
CONSULTING ENGINEERS
BOSTON, MASSACHUSETTS

SHEET NO. 1
JOB Dam Safety Inspect
SUBJECT Athol Mfg. Co. Dam
CLIENT COE

Athol Manufacturing Co. Dam

Hydraulic Data

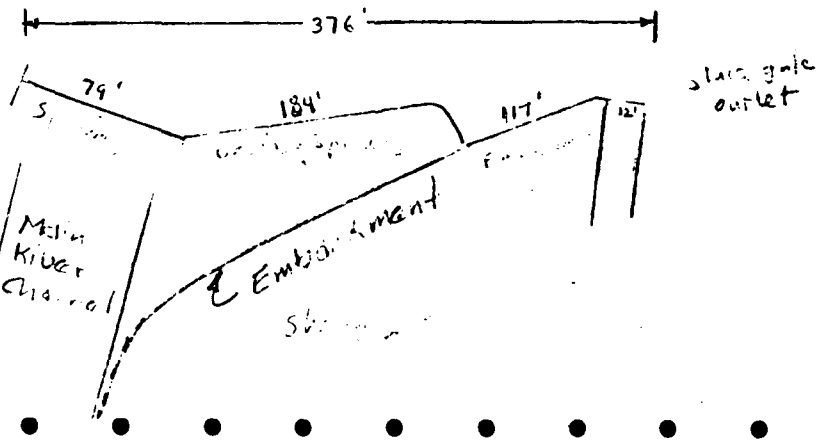
from COE Inventory of Dams in U.S. & State & Co. Inspection Reports

Dam Crest Length = 309' (Co. Rpt = 305')
Spillway crest width = 150 (Co Rpt 79')
Impoundment Capacity: max = 345 ac-ft
normal = 290 ac-ft

Structural Height = 20'
Hydraulic " = 17' (Co. Rpt = 11.5')

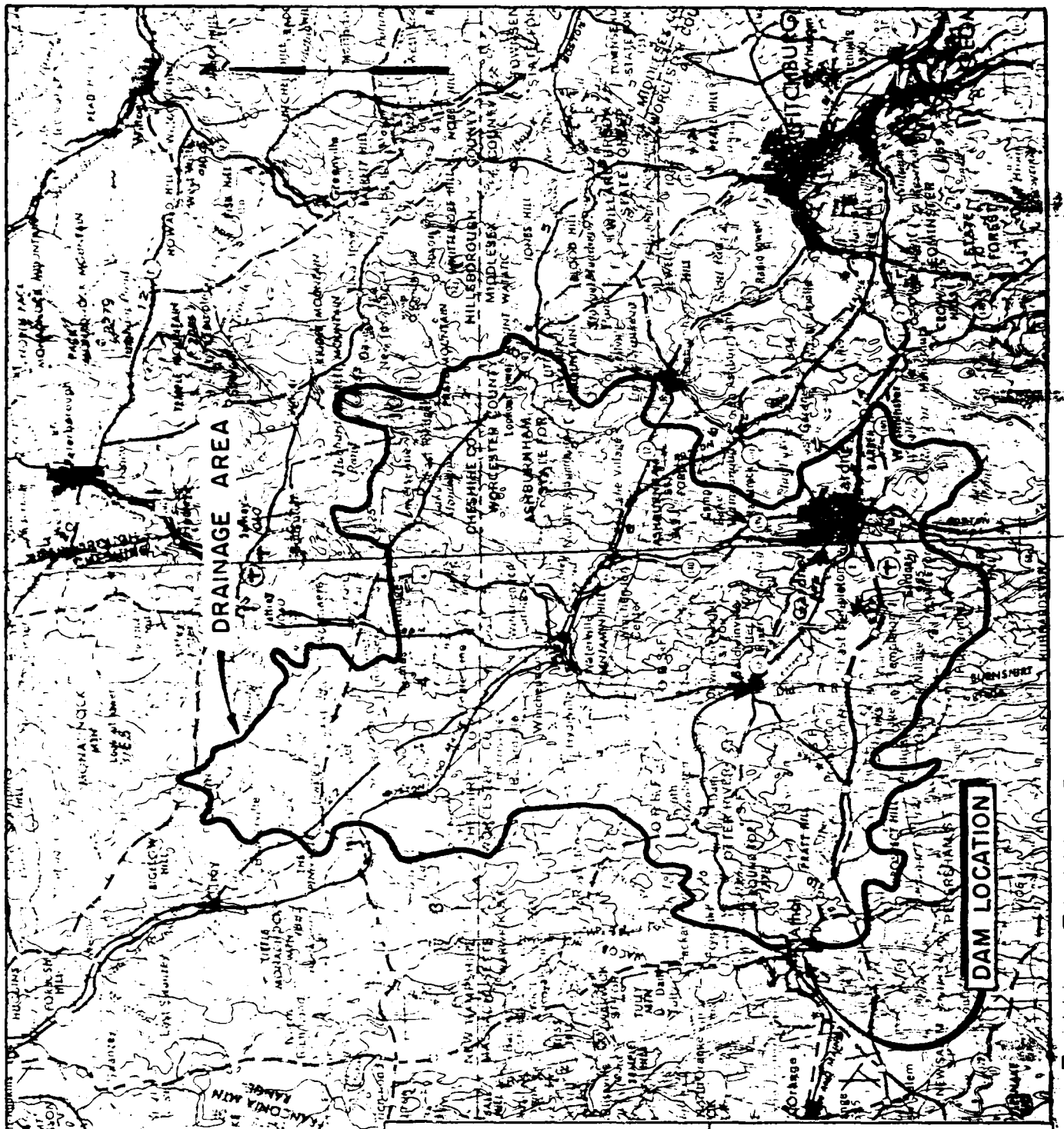
Hydraulic Data from field investigations & plans

Dam Crest Length = 392' (Inc. Embankment)
Spillway width = 79'
Hydraulic Height = 12'



APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



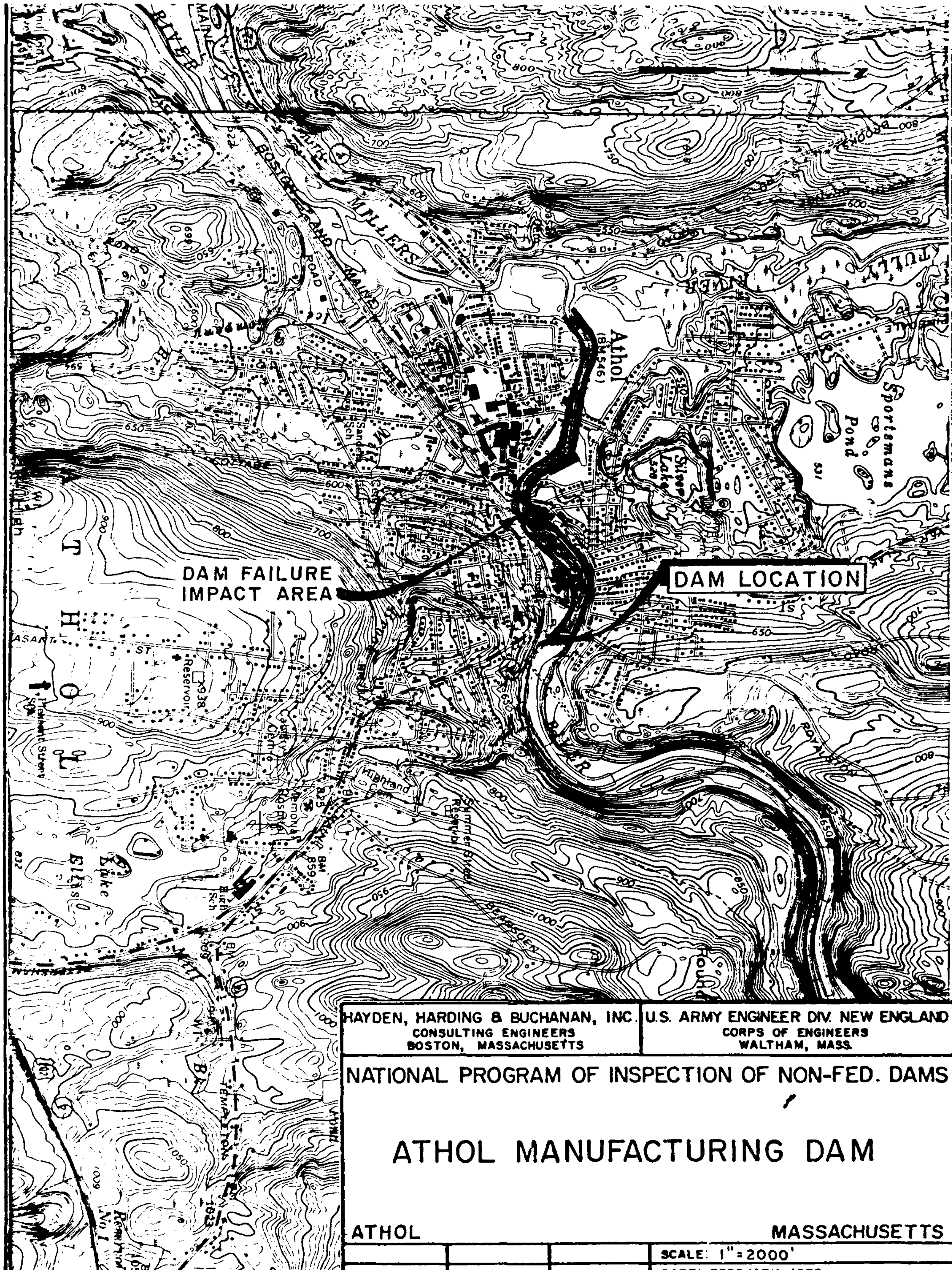
HAYDEN, HARDING & BUCHANAN, INC CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

ATHOL MANUFACTURING DAM

ATHOL MASSACHUSETTS

			SCALE 1" = 2.50,000"
			DATE FEBRUARY, 1979.



HAYDEN, HARDING & BUCHANAN, INC. CONSULTING ENGINEERS BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

ATHOL MANUFACTURING DAM

ATHOL MASSACHUSETTS

SCALE: 1" = 2000'

DATE: FEBRUARY, 1979.

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(10) NAME	(11) LATITUDE (NORTH)	(12) LONGITUDE (WEST)	(13) REPORT DATE DAY | MO | YR
MA	932	NED	MA	027	02				ATHOL MANUFACTURING DAM	4235.5	7215.1	23FEB79

(14) POPULAR NAME	(15) NAME OF IMPOUNDMENT
TWIST DRILL DAM	MILLERS RIVER

(16) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	08	MILLERS RIVER	ATHOL	0	11181

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	(27) IMPOUNDING CAPACITIES NORMAL (ACRE–FT.)
ERCTGRPG	1923	CH	22	19	500	290

DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
NED	N	N	N	N	07MAR79

(28) REMARKS

(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) SPILLWAY TYPE	(32) SPILLWAY WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) POWER CAPACITY PROPOSED (MW)	(37) NAVIGATION LOCKS NO.	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
1	376	C	79	20300												

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
UNION BUTTERFIELD DRILL	C.M.ALLEN	

(49) REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

(50) INSPECTION BY	(51) INSPECTION DATE DAY | MO | YR	(52) AUTHORITY FOR INSPECTION
HAYDEN HARDING + BUCHANAN, INC.	14NOV78	PUBLIC LAW 92-367

(53) REMARKS

END

FILMED

8-85

DTIC